Supreme Court, U.S.
FILED
AUG 31 2001
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(49)

No. 00-1543

In The

# Supreme Court of the United States

FESTO CORPORATION,

*Petitioner,*

v.

SHOKETSU KINZOKU KOGYO KABUSHIKI CO., LTD.,
a/k/a SMC CORPORATION and
SMC PNEUMATICS, INC.,

*Respondents.*

**On Writ Of Certiorari**
**To The United States Court Of Appeals**
**For The Federal Circuit**

## JOINT APPENDIX
## VOLUME II, PAGES II-1 TO II-231

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235 PP

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**EDITOR'S NOTE**

**THE FOLLOWING PAGES WERE POOR HARD COPY AT THE TIME OF FILMING. IF AND WHEN A BETTER COPY CAN BE OBTAINED, A NEW FICHE WILL BE ISSUED.**



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PLAINTIFF'S EXHIBIT 15

ALL-STATE LEGAL SUPPLY CO

U. S DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

January 31, 1992
(Date)

THIS IS TO CERTIFY that the annexed is a true copy from the records of this office

of U.S. Patent 4,354,125.

By authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

Certifying Officer.

United States Patent [19]
Stoll

[11] 4,354,125
[45] Oct. 12, 1982

[54] MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER

[76] Inventor: Kurt Stoll, Lenzhalde 72, D-7300 Esslingen, Fed. Rep. of Germany

[21] Appl. No.: 153,999

[22] Filed: May 28, 1980

[30] Foreign Application Priority Data

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[51] Int. Cl.³ ..... H02K 49/00
[52] U.S. Cl. ..... 310/103; 310/104
[53] Field of Search ..... 310/103, 104

[56] References Cited

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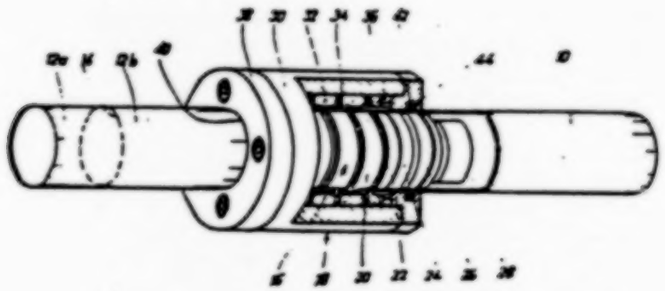
[57] ABSTRACT

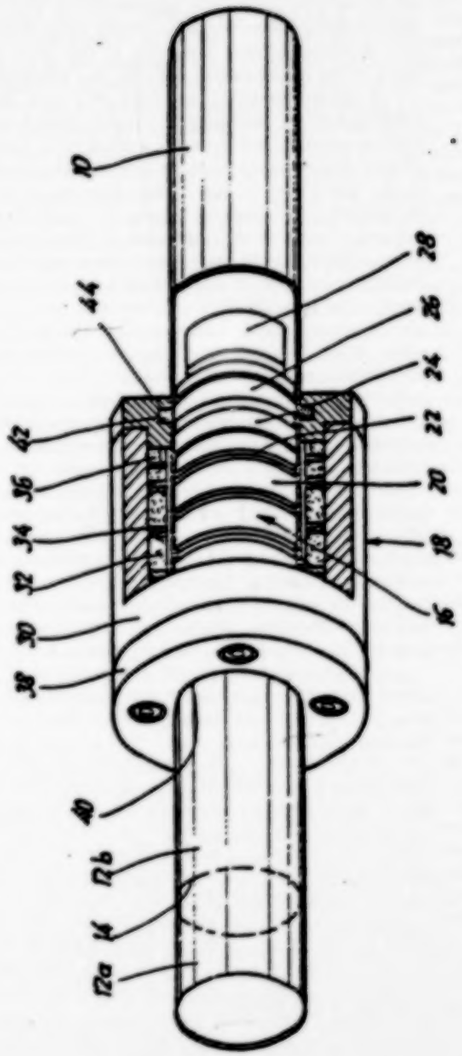
The invention is concerned with a magnetically coupled arrangement for a driving and a driven member, which arrangement is operable by a pressure medium and is used in a conveying system. A slidable piston (16) within a tube (10) has an arrangement of annular magnets (20) provided at each end with sealing and sliding members (24, 26). A driven assembly (18) slidable on the outer surface of the tube (10) has an arrangement of annular magnets (32) corresponding to the magnets (20) and provided at each end with a sliding ring (44). The members (24, 26, 44) prevent ingress of foreign bodies to the magnet locations, and consequently enable the spacing between the magnets and the tube (10) to be very small. A good magnetic coupling is achieved resulting in effective transmission of power. Several pistons (16) abutting one another can be used for conveying heavy loads.

7 Claims, 1 Drawing Figure









# MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER

## FIELD OF THE INVENTION

### Background of the Invention

The invention relates to a magnetically coupled arrangement operable by a pressure medium, and for use in a conveying system.

Magnetically coupled arrangements of this type are primarily used in conveying systems, having a driven assembly connected with a carriage for the goods to be conveyed. In this way, even goods of large size can be conveyed in a way similar to a pneumatic tube conveyor system.

In order to ensure trouble-free operation, the known magnetically coupled arrangement requires a greater degree of radial play between the adjacent surfaces of the magnet arrangements and the tube. It was generally agreed that this would be the only way of coping with the unavoidable surface roughness and cross-sectional irregularities of the tube. On the other hand, in the interests of increasing the magnetic drive force between the piston and the driven assembly, the total air gap between the two magnet arrangements would have to be kept as small as possible. A design incorporating a small air gap would require smaller, and thus lighter and substantially cheaper magnet arrangements than those used to date to achieve the required drive force between the piston and the driven assembly of the linear motor.

It was recognised that the non-magnetic materials available today have surface qualities good enough to enable by this alone a substantial reduction in the air gaps between magnet arrangements and tube surfaces in comparison with prior art, though unacceptable faults invariably developed in practical operation. These faults, however, have now been found to be due not to surface roughness and cross-sectional irregularities (superior surface quality can now be achieved even in butt-welded tube sections), but rather to the presence of dirt and impurities on the tube surfaces, which cannot pass through the small gaps between magnet arrangements and tube surfaces but tend to be wedged in said gaps.

According to the present invention there is provided a magnetically coupled arrangement for use in a conveying system, said motor being operable by a pressure medium and comprising a tubular part connectible to a source of the pressure medium, a piston which is slidable in said tubular part and which has sealing means at each end for wiping engagement with an internal surface of the tubular part and so as to form a seal for the pressure medium, and a driven assembly which is slidable on the tubular part and which has means at each end for wiping engagement with an external surface of the tubular part, the piston and the driven assembly each carrying a drive magnet arrangement in the form of a hollow cylindrical assembly, each magnet arrangement having radial play relative to the adjacent surface of the tubular part, and surfaces of the magnet arrangements which face the tubular part being closely adjacent to the respective surfaces of the tubular part.

Preferably the wiping means of the driven assembly and the sealing means of the piston lie in the same plane transversal to the axis of the tubular part. The contact pressure of the wiping means and sealing means does not exert a torsional deforming moment on the tubular part, which should preferably have thin walls in order to ensure a small total air gap between the two magnet arrangements.

Preferably also, the sealing means of the piston comprise sealing rings and the piston is provided with sliding guide rings near the sealing rings. The advantage of this is that a relatively soft material can be used for the piston sealing rings, which no longer have to perform any significant guiding functions. In this way, friction losses in the motor can be reduced to a minimum.

The tubular part may be made of a thin, stainless material such as non-magnetic special steel, brass or a plastics material, and water or a mixture of water and oil may be used as the pressure medium. The movement of the piston and of the driven assembly is initiated immediately the pressure medium is admitted and stopped as soon as the admission of pressure medium ceases, which permits extremely accurate positioning of the driven assembly by controlling the pressure medium supply. The pressure of the medium does not have to be high, since the piston is moved more by being carried along in the medium flow than by the admission of differential pressure.

If the driven assembly is provided with a sleeve made of a magnetisable material, which encircles the hollow cylindrical assembly of the magnet arrangement, magnetic leakage fields in the vicinity of the driven assembly can be kept to a minimum. In this way, undesirable braking forces, which would otherwise be generated while piston and driven assembly past magnetisable machine components, are avoided. By selecting a non-magnetisable material for the piston body, a more inhomogeneous magnetic field is generated in the space defined by the driven assembly, a favourable development in the interests of increasing the drive force.

Advantageously the magnet arrangements are represented by radially polarised annular magnets arranged in axial sequence and separated from each other by non-magnetisable spacer rings. The segmented structure of the magnet arrangements contributes to the creation of an axially inhomogeneous magnetic field, which again increases the drive force exerted on the driven assembly by the piston.

If the piston carries a flexible buffer at each end, the peripheral surface of which is spaced radially from the internal surface of the tubular part, the piston can be stopped very accurately by running into a rigid obstacle. A further advantage of this development lies in the fact that a piston of large overall axial dimensions can be constructed, which can pass through curved tube sections inspite of the small radial distance between the internal magnet arrangement and the internal tube surface. In this way a long magnetically coupled arrangement comprising articulated piston sections and corresponding magnetically coupled driven assemblies tiltable relative to each other is achieved. With a magnetically coupled arrangement of this design, a large load is distributed over a long tube section, the drive force between piston and driven assembly is satisfactory, and the piston can pass through curved tube sections.

## BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will now be described by way of example only with reference to the accompanying drawing, the single FIGURE of which is a perspective view of a magnetically coupled arrangement according to the invention, a section of the driven assembly and of the tube having been removed to show details of the piston.





## DETAILED DESCRIPTION

The drawing illustrates a magnetically coupled arrangement operated by a pressure medium, a relatively thin-walled and narrow tube 10 being made of a stainless, non-magnetic material such as non-magnetic special steel, brass or a plastics material, if preferred with glass reinforcement. The tube is made up of butt-welded or joined tube segments 12*a*. 12*b* joined by welds 14 which do not result in any surface irregularities in the internal or the external tube surface. Within the tube 10, which may be connected to a pressure medium source or sink at either or both ends, a piston 16 is movably arranged. A driven assembly 18 is movably mounted on the outside of the tube 10. A carriage for the goods to be conveyed, which is not illustrated here, can be attached to the driven assembly 18.

The piston 16 comprises a piston body made of aluminium or another light-weight non-magnetic material. This piston carries permanent annular magnets 20 which are arranged in axial sequence, and which are radially polarised and separated by spacers 22. At each end of the annular magnet arrangement which forms a hollow cylindrical assembly, the piston body is provided with sliding guide rings 24 partially seated in grooves on said piston body and projecting beyond the piston body surface, which sliding guide rings pass along the internal tube surface in a sliding fit. Outside, if viewed axially, of these sliding guide rings 24 are arranged elastomeric sealing rings 26, also seated in grooves on the piston body. Each end face of the piston carries a buffer 28, by which the piston 16 can be brought to a halt against a fixed stop, not illustrated here. These buffers 28 further serve in mechanically linking several pistons 16, as will be described in more detail below.

The external surface areas of the annular magnets 20 are very close to the internal surface of the tube 10. Since, however, the annular magnet arrangement 20 is enclosed on each side by a sliding guide ring 24 and a sealing ring 26, any impurities left in the tube 10 from its manufacturing process or carried along with the pressure medium, (preferably oil or a mixture of 95% water and 5% oil), cannot penetrate into the small gap between the outside of the annular magnet arrangement of the piston and the inside of the tube. Such impurities might otherwise result in the piston 16 seizing in the tube 10.

Instead, any such impurities are pushed along in front of the piston 16 by the sealing rings 26 or—should they manage to get past these—by the sliding guide rings 24, so that the annular magnet arrangement is invariably faced by a clean section of the internal tube wall.

The design of the driven assembly 18 of the magnetically coupled arrangement is essentially the inverse of the piston 16, the mirror image being a cylindrical surface midway between the external and the internal tube surfaces. The counterpart of the piston body is a sleeve 30 made of a magnetisable material to reduce magentic leakage fields. The sleeve 30 encloses permanent annular magnets 32 arranged in axial sequence, which magnets are radially polarised in the same direction as the annular magnets 20 and separated by spacers 34. The annular magnets 32 are clamped between two end faces 38 likewise made of a magnetisable material and bolted to the sleeve 30 by way of elastomeric thrust rings 36.

The end faces 38 have a central opening 40 encircling the tube 10 with little play, and in the peripheral inner surface of each end face 38, which is coated with a low friction material such as tetrafluoroethylene, is provided an inwardly opening groove 42 in which a wiper ring 44 is located. These wiper rings 44 ensure, in the case of the driven assembly 18, that the internal surface area of the hollow cylindrical magnet arrangement 32 is very close to the external surface of the tube 10, and that no foreign bodies can penetrate into the narrow gap between the annular magnets 32 and the tube surface. Any such foreign bodies, which commonly collect on tube surfaces not protected from the surrounding atmosphere, are pushed away by the wiper rings 44 before reaching the annular magnets 32.

Since the overall "air" gap between the internal magnet arrangement represented by the annular magnets 20 and the external magnet arrangement represented by the annular magnets 32 (this being made up of the distance between the annular magnets 20 and the internal tube surface, the wall thickness of the tube 10 and the distance between the annular magnets 32 and the external tube surface) can now be kept very small (there is no need for small foreign bodies to pass through between the magnet arrangements and the tube surfaces), a very good magnetic coupling can be achieved between the two annular magnet arrangements, resulting in effective transmission of the power provided by the pressure medium to the driven assembly.

As the illustration shows, there is a flush radial arrangement of the wiper rings 44 and the sealing rings 26, so that the contact force does not exert any torsional moment on the tube. This enables easy movement of the piston and the driven assembly along curved tube sections.

The magnetically coupled arrnagement described above is easily adapted for transporting heavier loads. Two pistons 16 are axially arranged in a tube section with auxiliary venting, the pistons butting against each other by their buffers 28, and driven assembly is provided for each piston to be automatically aligned with the corresponding piston by magnetic force. The carriage for the goods in then pivotally mounted on each of the driven assemblies. In this way, the two pistons now effectively form a piston of double (triple etc.) length with "articulated" individual pistons (held in contact by pressure), ensuring synchronous movement of the two (three etc.) driven assemblies. In this way, the weight of the load to be conveyed is distributed over a long tube section without, however, creating any passage problems such as would occur when using correspondingly long pistons and driven assemblies in conjunction with the small air gap, between magnet arrangements and tube surfaces which are specified in the invention. Even passage along curved tube sections is possible, which would not be the case with one-piece pistons and driven assemblies of corresponding length.

It is obvious that this effective lengthening of the driving and the load carrying assemblies can be achieved, without in any way modifying the standard components of the magnetically coupled arrangement, i.e. piston 16, driven assembly 18, for example on site and after completion of the initial installation. The distribution of the load over a longer section of the tube 10 is of special importance in the case of thin tubes, which in turn are preferable from the point of view of the magnetic coupling between piston and driven assembly. Thin plastic tubes, otherwise being an excellent solution

owing to their surface properties, tend to have inferior load carrying capacity, which is why articulated piston and driven assembly arrangements are especially suitable for tubes of this kind.

To stop the driven assembly at a certain point, a position transmitter acting on the pressure medium supply for the tube 10 is installed. This transmitter may either respond mechanically or optically to the approach of the driven assembly, or can alternatively be an inductive transmitter or a transmitter responding to magnetic leakage fields, e. g. a reed switch.

Various modifications may be made without departing from the invention.

Although a particular preferred embodiment of the invention has been disclosed in detail for illustrative purposes, it will be recognized that variations or modifications of the disclosed apparatus, including the rearrangement of parts, lie within the scope of the present invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an arrangement having a hollow cylindrical tube and driving and driven members movable thereon for conveying articles, the improvement comprising wherein said tube is made of a nonmagnetic material, wherein said driving member is a piston movably mounted on the inside of said tube, said piston having a piston body and plural axially spaced, first permanent annular magnets encircling said piston body, said piston further including first means spacing said first permanent magnets in said axial spaced relation, the radially peripheral surface of said magnets being oriented close to the internal wall surface of said tube, said piston further including plural guide ring means encircling said piston body and slidingly engaging said internal wall and first sealing rings located axially outside said guide rings for wiping said internal wall as said piston moves along said tube to thereby cause any impurities that may be present in said tube to be pushed along said tube so that said first annular magnets will be free of interference from said impurities, wherein said driven member includes a cylindrical sleeve made of a magnetizable material and encircles said tube, said sleeve having plural axially spaced second permanent annular magnets affixed thereto and in magnetically attracting relation to said first permanent annular magnets and second means spacing said second permanent annular magnets in said axially spaced relation, the radially inner surface of said magnets being oriented close to the external surface of said tube, said sleeve having end face means with second sealing rings located axially outside said second permanent annular magnets for wiping the external wall surface of said tube as said driven member is moved along said tube in response to a driving movement of said piston to thereby cause any impurities that may be present on said tube to be pushed along said tube so that said second permanent annular magnets will be free of interference from said impurities.

2. The arrangement according to claim 1, wherein said sealing rings on said driven member are formed as wiper rings which are seated in annular grooves opening inwardly on said end face means of said driven assembly.

3. The arrangement according to claim 1, wherein said sealing rings on said driven assembly and said sealing rings on said piston lie in the same plane perpendicular to the axis of said tube.

4. The arrangement according to claim 1 wherein said tube is made of a thin non-magnetic material, and wherein water or a mixture of water and oil is used as the pressure medium.

5. The arrangement according to claim 1, wherein said sealing rings are formed of a pliable, elastic material.

6. The arrangement according to claim 1, wherein said piston body is made of a non-magnetisable material.

7. The arrangement according to claim 1, wherein said piston has a flexible buffer at each end, the peripheral surface of which is spaced radially from the internal surface of said tube.

* * * * *





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PLAINTIFF'S EXHIBIT 14
ALL-STATE LEGAL SUPPLY CO.

310-103

# ...LAR UTILITY

| NUMBER PATENT | PATENT DATE | | | | |
|---|---|---|---|---|---|
| 153999 | 12 OCT 1982 | | | | |
| NUMBER | FILING DATE | CLASS | SUBCLASS | GROUP ART UNIT | |
| 06/...999 | 05/28/80 | 060 | | 34[illegible] | |

APPLICANTS: K...TOLL, ESSLINGEN, FED REP GERMANY.

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...N/PCT APPLICATIONS**********
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| | | | | | | DEX | 1 | 12 | 1 | $ 71 | MLR CASE 28 |

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KA... MI 49008

TITLE: ~~EL... OR OPERABLE BY A PRESSURE MEDIUM~~
...Mechanically Coupled Arrangement for a Driving and a Driven Member

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M. Lee
Certifying Officer

...AN 31 1992



[redacted]

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## CONTENTS

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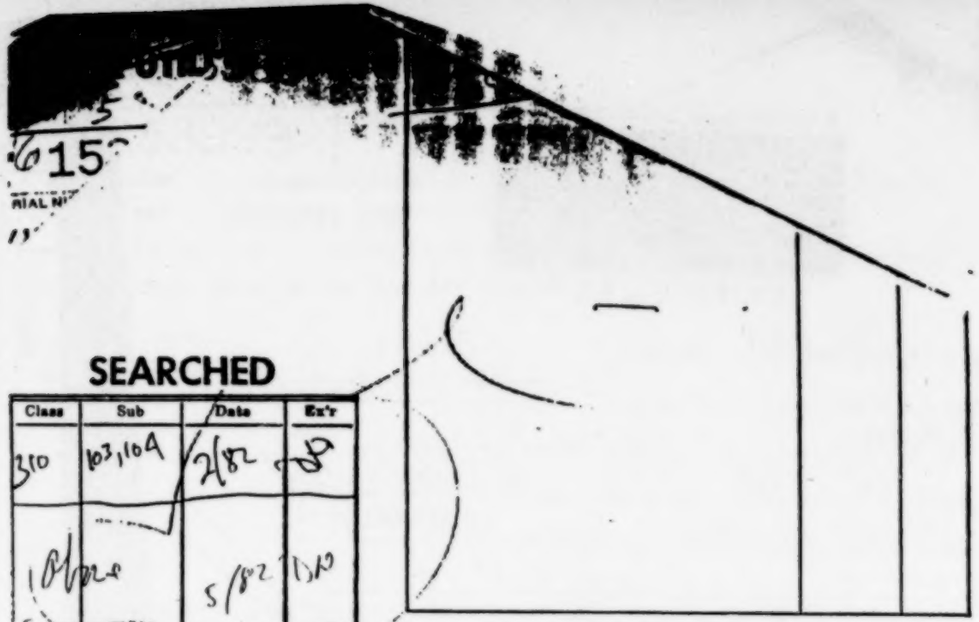

## SEARCHED

| Class | Sub | Date | Ex'r |
|---|---|---|---|
| 310 | 103,104 | 2/82 | DP |
| 1 Abn | | 5/82 | DP |

## INTERFERENCE SEARCHED

| Class | Sub | Date | Ex'r |
|---|---|---|---|
| 310 | 80, 107, 101 | 5/82 | DP |

PRINT CLAIM(S): 1

## INDEX OF CLAIMS

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SYMBOLS — STATUS

- V ..... Rejected
- = ..... Allowed
- ~ (Through numeral) Canceled
- + ..... Restriction requirement
- N ..... Nonelected invention or species
- I ..... Interference
- A ..... Appeal
- O ..... Objected



...LAR UTILITY

4354125

| SERIAL NUMBER | FILING DATE | CLASS | SUBCLASS | GROUP ART UNIT | |
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310-103

APPLICANTS: KURT STOLL, ESSLINGEN, FED REP GERMANY.

LLX

**CONTINUING DATA**********
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Foreign priority claimed 35 USC 119 conditions met — Yes — Verified and Acknowledged — Examiner's Initials

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| | DEX | 1 | 12 | 1 | $ 21 | NLR CASE 28 |

ADDRESS: BLANCHARD, FLYNN, THIEL, BOUTELL & TANIS, 2026 RAMBLING RD, KALAMAZOO, MI 49008

TITLE: ~~LINEAR MOTOR OPERABLE BY A PRESSURE MEDIUM~~ Magnetically Coupled Arrangement for a Driving and a Driven Member

U.S. DEPT. of COMM.-Pat. & TM Office — PTO-436L (rev. 10-71)

PARTS OF APPLICATION FILED SEPARATELY

AT ALLOWANCE

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|---|---|---|---|---|
| 1 | 1 | 3 | 310 | 103 |

PREPARED FOR ISSUE 6/7/82

(Assistant Examiner) — (Docket Clerk)

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...Y EXAMINER
T UNIT 212

(Primary Examiner) — (Art Unit)

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| 6-2-82 | 7/22/82 |

RETENTION LABEL: K85

153999

Applicant : Kurt Stoll

Invention : A LINEAR MOTOR OPERABLE BY A PRESSURE MEDIUM

Honorable Commissioner of Patents and Trademarks
Washington, D. C. 20231
Sir:

Herewith is the above-identified application comprising the following parts:

- [x] Specification
- [x] Declaration ~~axx&xkk~~
- [1] Sheet(s) of [x] Formal [ ] Informal Drawings

| | |
|---|---|
| Basic Filing Fee | $65.00 |
| Additional Fees: | |
| Total number of claims in excess of 10, times $2.00 | 6.00 |
| Number of independent claims minus 1, times $10.00 | .00 |
| Total Filing Fee | $71.00 |

- [x] Please charge $ 71.00 to Deposit Account No. 02-2675. A duplicate copy of this sheet is enclosed.
- [x] The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account No. 02-2675. A duplicate copy of this sheet is enclosed.
- [ ] Letter re Assignment
- [ ] Claim of Priority
- [x] Acknowledgment Postal Card

Respectfully submitted,

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RJT/1
IN DUPLICATE
Encl: As Listed Above
(616) 381-1156

P. S. Applicant wishes to claim the priority of German Patent Application Serial No. P 29 22 444.0, filed June 1, 1979.



153999

SD 10-6-80

~~A Linear Motor Operable by a~~
~~Pressure Medium~~
a Magnetically Coupled Arrangement for a Driving and a Driven Member

Abstract of the Disclosure

The invention is concerned with a ~~linear motor~~ arrangement which is operable by a pressure medium and is used in a conveying system. A slidable piston (16) within a tube (10) has an arrangement of annular magnets (20) provided at each end with sealing and sliding members (24, 26). A driven assembly (18) slidable on the outer surface of the tube (10) has an arrangement of annular magnets (32) corresponding to the magnets (20) and provided at each end with a sliding ring (44). The members (24, 26, 44) prevent ingress of foreign bodies to the magnet locations, and consequently enable the spacing between the magnets and the tube (10) to be very small. A good magnetic coupling is achieved resulting in effective transmission of power. Several pistons (16) abutting one another can be used for conveying heavy loads.

# A Linear Motor Operable by a Pressure Medium

a Field of the Invention

a Background of the Invention

The invention relates to a ~~linear motor~~ magnetically coupled arrangement operable by a pressure medium, and for use in a conveying system.

B Magnetically coupled arrangements ~~linear motors~~ of this type are primarily used in conveying systems, having a driven assembly connected with a carriage for the goods to be conveyed. In this way, even goods of large size can be conveyed in a way similar to a pneumatic tube conveyor system.

B In order to ensure trouble-free operation, the known ~~linear motor~~ magnetically coupled arrangement requires a greater degree of radial play between the adjacent surfaces of the magnet arrangements and the tube. It was generally agreed that this would be the only way of coping with the unavoidable surface roughness and cross-sectional irregularities of the tube. On the other hand, in the interests of increasing the magnetic drive force between the piston and the driven assembly, the total air gap between the two magnet arrangements would have to be kept as small as possible. A design incorporating a small air gap would require smaller, and thus lighter and substantially cheaper magnet arrangements than those used to date to achieve the required drive force between the piston and the driven assembly of the linear motor.





It was recognised that the non-magnetic materials available today have surface qualities good enough to enable by this alone a substantial reduction in the air gaps between magnet arrangements and tube surfaces in comparison with prior art, though unacceptable faults invariably developed in practical operation. These faults, however, have now been found to be due not to surface roughness and cross-sectional irregularities (superior surface quality can now be achieved even in butt-welded tube sections), but rather to the presence of dirt and impurities on the tube surfaces, which cannot pass through the small gaps between magnet arrangements and tube surfaces but tend to be wedged in said gaps.

B According to the present invention there is provided a ~~linear motor~~ magnetically coupled arrangement for use in a conveying system, said motor being operable by a pressure medium and comprising a tubular part connectible to a source of the pressure medium, a piston which is slidable in said tubular part and which has sealing means at each end for wiping engagement with an internal surface of the tubular part and so as to form a seal for the pressure medium, and a driven assembly which is slidable on the tubular part and which has means at each end for wiping engagement with an external surface of the tubular part, the piston and the driven assembly each carrying a drive magnet arrangement in the form of a hollow cylindrical assembly, each magnet arrangement having radial play relative to the adjacent surface of the tubular part, and surfaces of the magnet arrangements which face the tubular part being closely adjacent to the respective surfaces of the tubular part.

Preferably the wiping means of the driven assembly and the sealing means of the piston lie in the same plane transversal to the axis of the tubular part. The contact pressure of the wiping means and sealing means does not exert a torsional deforming moment on the tubular part, which should preferably have thin walls in order to ensure a small total air gap between the two magnet arrangements.

Preferably also, the sealing means of the piston comprise sealing rings and the piston is provided with sliding guide rings near the sealing rings. The advantage of this is that a relatively soft material can be used for the piston sealing rings, which no longer have to perform any significant guiding functions. In this way, friction losses in the motor can be reduced to a minimum.

The tubular part may be made of a thin, stainless material such as non-magnetic special steel, brass or a plastics material, and water or a mixture of water and oil may be used as the pressure medium. The movement of the piston and of the driven assembly is initiated immediately the pressure medium is admitted and stopped as soon as the admission of pressure medium ceases, which permits extremely accurate positioning of the driven assembly by controlling the pressure medium supply. The pressure of the medium does not have to be high, since the piston is moved more by being carried along in the medium flow than by the admission of differential pressure.





If the driven assembly is provided with a sleeve made of a magnetisable material, which encircles the hollow cylindrical assembly of the magnet arrangement, magnetic leakage fields in the vicinity of the driven assembly can be kept to a minimum. In this way, undesirable braking forces, which would otherwise be generated while piston and driven assembly pass magnetisable machine components, are avoided. By selecting a non-magnetisable material for the piston body, a more inhomogeneous magnetic field is generated in the space defined by the driven assembly, a favourable development in the interests of increasing the drive force.

Advantageously the magnet arrangements are represented by radially polarised annular magnets arranged in axial sequence and separated from each other by non-magnetisable spacer rings. The segmented structure of the magnet arrangements contributes to the creation of an axially inhomogeneous magnetic field, which again increases the drive force exerted on the driven assembly by the piston.

If the piston carries a flexible buffer at each end, the peripheral surface of which is spaced radially from the internal surface of the tubular part, the piston can be stopped very accurately by running into a rigid obstacle. A further advantage of this development lies in the fact that a piston of large overall axial dimensions can be constructed, which can pass through curved tube sections inspite of the small radial distance between the internal magnet arrangement and the internal tube surface. In this

way a long magnetically coupled arrangement ~~linear motor~~ comprising articulated piston sections and corresponding magnetically coupled driven assemblies tiltable relative to each other is achieved. With a magnetically coupled arrangement ~~linear motor~~ of this design, a large load is distributed over a long tube section, the drive force between piston and driven assembly is satisfactory, and the piston can pass through curved tube sections.

## Brief Description of the Drawings

An embodiment of the invention will now be described by way of example only with reference to the accompanying drawing, the single figure of which is a perspective view of a magnetically coupled arrangement ~~linear motor~~ according to the invention, a section of the driven assembly and of the tube having been removed to show details of the piston.

## Detailed Description

The drawing illustrates a magnetically coupled arrangement ~~linear motor~~ operated by a pressure medium, a relatively thin-walled and narrow tube 10 being made of a stainless, non-magnetic material such as non-magnetic special steel, brass or a plastics material, if preferred with glass reinforcement. The tube is made up of butt-welded or joined tube segments 12a, 12b joined by welds 14 which do not result in any surface irregularities in the internal or the external tube surface. Within the tube 10, which may be connected to a pressure medium source or sink at either or both ends, a piston 16 is movably arranged. A driven assembly 18 is movably mounted on ~~passing along~~ the outside of the tube 10. A carriage for the goods to be conveyed, which is not illustrated here, can be attached to the driven assembly 18.





The piston 16 comprises a piston body made of aluminium or another light-weight non-magnetic material. This piston carries permanent annular magnets 20 which are arranged in axial sequence, and which are radially polarised and separated by spacers 22. At each end of the annular magnet arrangement which forms a hollow cylindrical assembly, the piston body is provided with sliding guide rings 24 partially seated in grooves on said piston body and projecting beyond the piston body surface, which sliding guide rings pass along the internal tube surface in a sliding fit. Outside, if viewed axially, of these sliding guide rings 24 are arranged elastomeric sealing rings 26, also seated in grooves on the piston body. Each end face of the piston carries a buffer 28, by which the piston 16 can be brought to a halt against a fixed stop, not illustrated here. These buffers 28 further serve in mechanically linking several pistons 16, as will be described in more detail below.

The external surface areas of the annular magnets 20 are very close to the internal surface of the tube 10. Since, however, the annular magnet arrangement 20 is enclosed on each side by a sliding guide ring 24 and a sealing ring 26, any impurities left in the tube 10 from its manufacturing process or carried along with the pressure medium, (preferably oil or a mixture of 95 % water and 5 % oil), cannot penetrate into the small gap between the outside of the annular magnet arrangement of the piston and the inside of the tube. Such impurities might otherwise result in the piston 16 seizing in the tube 10.

Instead, any such impurities are pushed along in front of the piston 16 by the sealing rings 26 or - should they manage to get past these - by the sliding guide rings 24, so that the annular magnet arrangement is invariably faced by a clean section of the internal tube wall.

The design of the driven assembly 18 of the linear motor is essentially the inverse of the piston 16, the mirror image being a cylindrical surface midway between the external and the internal tube surfaces. The counterpart of the piston body is a sleeve 30 made of a magnetisable material to reduce magnetic leakage fields. The sleeve 30 encloses permanent annular magnets 32 arranged in axial sequence, which magnets are radially polarised in the same direction as the annular magnets 20 and separated by spacers 34. The annular magnets 32 are clamped between two end faces 38 likewise made of a magndisable material and bolted to the sleeve 30 by way of elastomeric thrust rings 36.

The end faces 38 have a central opening 40 encircling the tube 10 with little play, and in the peripheral inner surface of each end face 38, which is coated with a low friction material such as tetrafluorethylene, is provided an inwardly opening groove 42 in which a wiper ring 44 is located. These wiper rings 44 ensure, in the case of the driven assembly 18, that the internal surface area of the hollow cylindrical magnet arrangement 32 is very close to the external surface of the tube 10, and that no foreign bodies can penetrate into the narrow gap between the annular magnets 32 and the tube surface. Any such foreign bodies,





which commonly collect on tube surfaces not protected from the surrounding atmosphere, are pushed away by the wiper rings 44 before reaching the annular magnets 32.

Since the overall "air" gap between the internal magnet arrangement represented by the annular magnets 20 and the external magnet arrangement represented by the annular magnets 32 (this being made up of the distance between the annular magnets 20 and the internal tube surface, the wall thickness of the tube 10 and the distance between the annular magnets 32 and the external tube surface) can now be kept very small (there is no need for small foreign bodies to pass through between the magnet arrangements and the tube surfaces), a very good magnetic coupling can be achieved between the two annular magnet arrangements, resulting in effective transmission of the power provided by the pressure medium to the driven assembly.

As the illustration shows, there is a flush radial arrangement of the wiper rings 44 and the sealing rings 26, so that the contact force does not exert any torsional moment on the tube. This enables easy movement of the piston and the driven assembly along curved tube sections.

The magnetically coupled arrangement described above is easily adapted for transporting heavier loads. Two pistons 16 are axially arranged in a tube section with auxiliary venting, the pistons butting against each other by their buffers 28, and driven assembly is provided for each piston to be automatically aligned with the corresponding piston by magnetic force. The carriage for the goods is then pivotally mounted on each of the driven assemblies. In this way, the two pistons now effectively form a piston of double ( triple etc.) length with "articulated"

individual pistons (held in contact by pressure), ensuring synchronous movement of the two (three etc.) driven assemblies. In this way, the weight of the load to be conveyed is distributed over a long tube section without, however, creating any passage problems such as would occur when using correspondingly long pistons and driven assemblies in conjunction with the small air gaps between magnet arrangements and tube surfaces which are specified in the invention. Even passage along curved tube sections is possible, which would not be the case with one-piece pistons and driven assemblies of corresponding length.

It is obvious that this effective lengthening of the driving and the load carrying assemblies can be achieved, without in any way modifying the standard components of the B magnetically coupled arrangement ~~linear motor~~, i.e. piston 16, driven assembly 18, for example on site and after completion of the initial installation. The distribution of the load over a longer section of the tube 10 is of special importance in the case of thin tubes, which in turn are preferable from the point of view of the magnetic coupling between piston and driven assembly. Thin plastic tubes, otherwise being an excellent solution owing to their surface properties, tend to have inferior load carrying capacity, which is why articulated piston and driven assembly arrangements are especially suitabl for tubes of this kind.

To stop the driven assembly at a certain point, a position transmitter acting on the pressure medium supply for the tube 10 is installed. This transmitter may either





respond mechanically or optically to the approach of the driven assembly, or can alternatively be an inductive transmitter or a transmitter responding to magnetic leakage fields, e. g. a reed switch.

Various modifications may be made without departing from the invention.

Although a particular preferred embodiment of the invention has been disclosed in detail for illustrative purposes, it will be recognized that variations or modifications of the disclosed apparatus, including the rearrangement of parts, lie within the scope of the present invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A linear motor for use in a conveying system, said motor being operable by a pressure medium and comprising a tubular part connectible to a source of the pressure medium, a piston which is slidable in said tubular part and which has sealing means at each end for wiping engagement with an internal surface of the tubular part and so as to form a seal for the pressure medium, and a driven assembly which is slidable on the tubular part and which has means at each end for wiping engagement with an external surface of the tubular part, the piston and the driven assembly each carrying a drive magnet arrangement in the form of a hollow cylindrical assembly, each magnet arrangement having radial play relative to the adjacent surface of the tubular part, and surfaces of the magnet arrangements which face the tubular part being closely adjacent to the respective surfaces of the tubular part.

2. A linear motor according to claim 1, wherein the wiping means of the driven assembly are formed as wiper rings which are seated in annular grooves opening inwardly on radial end walls of the driven assembly.

3. A linear motor according to claim 1 or 2, wherein the wiping means of the driven assembly and the sealing means of the piston lie in the same plane transversal to the axis of the tubular part.





4. A linear motor according to any of claims 1 to 3, wherein the sealing means of the piston comprise sealing rings and the piston is provided with sliding guide rings near the sealing rings.

5. A linear motor according to any of the preceding claims, wherein the tubular part is made of a thin, stainless material such as non-magnetic special steel, brass or a plastics material, and wherein water or a mixture of water and oil is used as the pressure medium.

6. A linear motor according to any of the preceding claims, wherein the tubular part comprises a plurality of tube segments butt welded to each other.

7. A linear motor according to any of the preceding claims, wherein the wiping means and the sealing means are formed of a pliable, elastic material.

8. A linear motor according to any of the preceding claims, wherein the driven assembly is provided with a sleeve made of a magnetisable material, which encircles the hollow cylindrical assembly of the magnet arrangement.

9. A linear motor according to any of the preceding claims, wherein the piston has a body made of a non-magnetisable material.

A linear motor according to any of the preceding claims, wherein the magnet arrangements are represented by radially polarised annular magnets arranged in axial sequence and separated from each other by non-magnetisable spacer-rings.

Sub. a6

~~11. A linear motor according~~ to any of the preceding claims, wherein the piston carries a flexible buffer at each end, the peripheral surface of which is spaced radially from the ~~internal surface of the tubular part.~~

~~12. A linear motor~~ according to claim 11, which comprises a plurality of pistons, the buffers of which butt against each other, and an equivalent number of driven assemblies, ~~each of the latter corresponding to one of the pistons.~~

add a 1



UNITED STATES OF AMERICA

| EIDESSTATTLICHE ERKLÄRUNG UND VOLLMACHT FÜR ERSTANMELDUNGEN *(GERMAN LANGUAGE DECLARATION FOR ORIGINAL PATENT APPLICATION)* | ATTORNEY'S DOCKET NO. (IF ANY) M&R Case 28 |
|---|---|

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:
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"Druckmittelbetätigter Linearmotor"

[the invention entitled: A Linear Motor Operable by a Pressure Medium]

bin, die in der beiliegenden Patentanmeldung beschrieben und beansprucht wird; dass ich den Inhalt dieser beiliegenden Patent anmeldung voll verstehe; dass der Inhalt derselben nach meinem besten Wissen und Glauben noch nie vor meiner oder unserer Erfindung ihres Gegenstandes in den Vereinigten Staaten von Amerika bekannt war oder benutzt oder patentiert oder vor meiner oder unserer Erfindung oder vor mehr als einem Jahr vor dem Tag dieser Anmeldung in irgendeinem Land in irgendwelchen gedruckten Veröffentlichungen beschrieben wurde; dass dieselbe vor mehr als einem Jahr vor dem Tag ihrer Anmeldung in den Vereinigten Staaten von Amerika weder in öffentlichem Gebrauch war noch zum Verkauf angeboten wurde; dass diese Erfindung vor dem Tag inhrer Anmeldung in keinem ausländischen Land ausserhalb der Vereinigten Staaten von Amerika patentiert wurde oder der Gegenstand einer Erfinder-Urkunde in einer Patentanmeldung war, die von mir oder von meinen gesetzlichen Vertretern oder Rechtsnachfolgern vor mehr als zwölf Monaten vor dem Tag dieser Anmeldung hinterlegt wurde; dass ich hiermit meine Pflicht zur Offenbarung irgendwelcher mir bekannter Informationen anerkenne, die für die Prüfung der vorliegenden Anmeldung von Wichtigkeit sind; und dass vor dem Tag dieser Anmeldung von mir oder meinen gesetzlichen Vertretern oder Rechtsnachfolgern mit Ausnahme der nachstehend angeführten Patentanmeldung(en) für diese Erfindung in keinem Land ausserhalb der Vereinigten Staaten von Amerika eine Anmeldung für ein Patent oder eine Erfinder-Urkunde für diese Erfindung hinterlegt worden ist:

| COUNTRY | APPLICATION NUMBER | DATE OF FILING (day, month, year) | PRIORITY CLAIMED UNDER 35 U.S.C. 119 |
|---|---|---|---|
| Germany | P 29 22 444.0 | 1.6.1979 | YES X NO |
| | | | YES NO |

Ich beauftrage hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Paten- und Warenzeichen-Amt:

Raywood H. Blanchard (Reg. No. 16 383), L. Martin Flynn (Reg. No. 17 835), Dale H. Thiel (Reg. No. 24 323), David G. Boutell (Reg. No. 25 072) and Ronald J. Tanis (Reg. No. 22 724)

[POWER OF ATTORNEY: Raywood H. Blanchard (Reg. No. 16 383), L. Martin Flynn (Reg. No. 17 835), Dale H. Thiel (Reg. No. 24 323), David G. Boutell (Reg. No. 25 072) and Ronald J. Tanis (Reg. No. 22 724)]

Bitte alle Telephongespräche unter Rufnummer (616) 381-1156 an den Rechtsanwalt, der den Anmeldungsuebermittlungsbrief unterschreibt richten.

[Address all telephone calls to attorney signing the application transmittal letter at telephone no. (616) 381-1156]

Postzustellanschrift: BLANCHARD, FLYNN, THIEL, BOUTELL & TANIS
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[Address all correspondence to BLANCHARD, FLYNN, THIEL, BOUTELL & TANIS
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*(Provide equivalent information in English between brackets)*

FORM PTO-2041 (10-77)

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*(German Language Declaration for Original Patent Application)*

Page 2

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| VOLLER NAME DES EINZIGEN ODER URSPRÜNGLICHEN ERFINDERS | FULL NAME OF SOLE OR FIRST INVENTOR |
|---|---|
| Kurt Stoll | |
| UNTERSCHRIFT DES ERFINDERS DATUM | |
| K. Stoll 5.5.80 | |
| WOHNSITZ | RESIDENCE |
| Esslingen | |
| STAATSANGEHÖRIGKEIT | CITIZENSHIP |
| German | |
| POSTANSCHRIFT | POST OFFICE ADDRESS |
| Lanzhalde72 | |
| D-7300 Esslingen | |

| VOLLER NAME DES ZWEITEN MITERFINDERS (FALLS ZUTREFFEND) | FULL NAME OF SECOND JOINT INVENTOR, IF ANY |
|---|---|
| UNTERSCHRIFT DES ERFINDERS DATUM | |
| WOHNSITZ | RESIDENCE |
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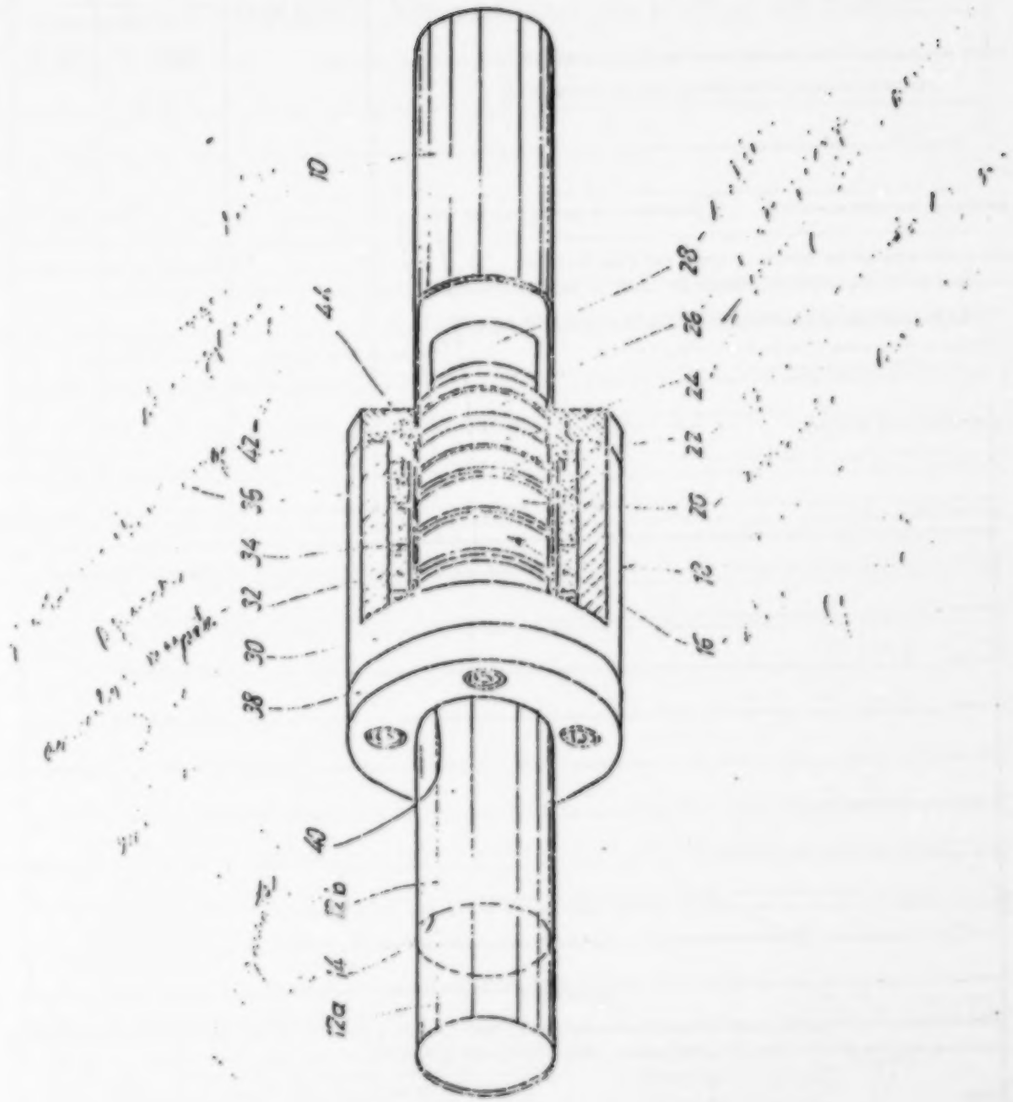
*(Falls dritte und weitere Miterfinder, die vorstehenden Angaben bitte durch entsprechende Informationen zur Person dieser Erfinder und Unterschriften ergänzen)*

Patent & TM Office - U.S. COMM-D.C.



PRINT OF DRAWING
AS ORIGINALLY FILED

Reinhard Hummelsheim
P.R. Case 28
Ass'Short




1-1

**UNITED STATES DEPARTMENT OF COMMERCE**
**Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

| SERIAL NUMBER | FILING DATE | FIRST NAMED APPLICANT | ATTORNEY DOCKET NO. |
|---|---|---|---|
| 06/153,999 | 05/28/80 | STOLL K | M&R CASE 28 |

BLANCHARD, FLYNN, THIEL,
BOUTELL & TANIS
2026 RAMBLING RD,
KALAMAZOO, MI 49008

| EXAMINER | |
|---|---|
| | |
| ART UNIT | PAPER NUMBER |
| 212 | 2 |

DATE MAILED: ~~07/01/81~~ JUL 2 1981

This is a communication from the examiner in charge of your application.

COMMISSIONER OF PATENTS AND TRADEMARKS

☑ This application has been examined. ☐ Responsive to communication filed on _____ ☐ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), _____ days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

**Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:**

1. ☑ Notice of References Cited by Examiner, PTO-892
2. ☐ Notice of Informal Patent Drawing, PTO-948
3. ☐ Notice of References Cited by Applicant, PTO-1449
4. ☐ Notice of Informal Patent Application, Form PTO-152
5. ☐ _____

**Part II SUMMARY OF ACTION**

1. ☑ Claims 1-12 are pending in the application.
   Of the above, claims _____ are withdrawn from consideration.
2. ☐ Claims _____ have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☑ Claims 1-12 are rejected.
5. ☐ Claims _____ are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☐ The formal drawings filed on _____ are acceptable.
8. ☐ The drawing correction request filed on _____ has been ☐ approved. ☐ disapproved.
9. ☑ Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has
   ☐ been received. ☑ not been received. ☐ been filed in parent application, serial no. _____,
   filed on _____.
10. ☐ Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
11. ☐ Other

PTOL-326 (rev. 7-79) **EXAMINER'S ACTION**



PTO-[redacted]

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

SERIAL NUMBER 153,999 GROUP ART UNIT 212

**PART III**

**NOTIFICATION OF REJECTION(S) AND/OR OBJECTION(S) (35 USC 132)**

| | CLAIMS (1) | REASONS FOR REJECTION (2) | REFERENCES * (3) | INFORMATION IDENTIFICATION AND COMMENTS (4) |
|---|---|---|---|---|
| 1 | 1-12 | 35 USC 112 (1ST PP) | — | EXACT METHOD OF OPERATION UNCLEAR. IS DEVICE A TRUE MOTOR OR MAGNETIC CLUTCH? |
| 2 | 4-12 | 35 USC 112 (2ND PP) | | IMPROPERLY MULTIPLY DEPENDENT |
| 3 | | | | |
| 4 | | | | |
| 5 | CITED REFS BELIEVED PERTINENT | | | |

* Capital letters representing references are identified on accompanying Form PTO-892
The symbol "v" between letters represents - in view of -.
The symbol "+" or "&" between letters represents - and -.
A slash "/" between letters represents the alternative - or -.

NOTE: Sections 100, 101, 102, 103, and 112 of the Patent Statute (Title 35 of the United States Code) are reproduced on the back of this sheet.

EXAMINER Donovan F. Duggan TEL. NO. (703) — 557 5050
DONOVAN F. DUGGAN
PRIMARY EXAMINER
ART UNIT 212

2

FORM PTO-892 (REV. 3-78) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

NOTICE OF REFERENCES CITED

| SERIAL NO. | GROUP ART UNIT | ATTACHMENT TO PAPER NUMBER | |
|---|---|---|---|
| 153,999 | 212 | | |
| APPLICANT(S) Stoll | | | |

U.S. PATENT DOCUMENTS

| * | | DOCUMENT NO. | DATE | NAME | CLASS | SUB-CLASS | FILING DATE IF APPROPRIATE |
|---|---|---|---|---|---|---|---|
| ✓ | A | 2998485 | 8/59 | Richter et al. | 36 | 104 | |
| ✓ | B | 1697142 | 1/29 | Keller | 310 | 104X | |
| ✓ | C | 3847502 | 11/74 | Isbell | 318 | 104X | |
| | D | | | | | | |
| | E | | | | | | |
| | F | | | | | | |
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| | J | | | | | | |
| | K | | | | | | |

FOREIGN PATENT DOCUMENTS

| * | | DOCUMENT NO. | DATE | COUNTRY | NAME | CLASS | SUB-CLASS | PERTINENT SHTS. DWG. | PERTINENT PP. SPEC. |
|---|---|---|---|---|---|---|---|---|---|
| | L | | | | | | | | |
| | M | | | | | | | | |
| | N | | | | | | | | |
| | O | | | | | | | | |
| | P | | | | | | | | |
| | Q | | | | | | | | |

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

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| R | |
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| EXAMINER | DATE |
|---|---|
| D. Duggan | 2/82 |

* A copy of this reference is not being furnished with this office action. (See Manual of Patent Examining Procedure, section 707.05 (a).)



MAIL ROOM 11 OCT 2 1981 PAT. & TRADE MARK OFF.

Applicant : Kurt STOLL

Serial No.: 153 999 Group 212

Filed : May 28, 1980 Examiner D. Duggan

For : LINEAR MOTOR OPERABLE BY A PRESSURE MEDIUM

Honorable Commissioner of Patents and Trademarks

Washington, D. C. 20231

CERTIFICATE OF MAILING

Sir:

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on

SEP 30 1981.

BLANCHARD, FLYNN, THIEL, BOUTELL & TANIS, P.C.

Raywood H. Blanchard, Reg. No. 16 383
L. Martin Flynn, Reg. No. 17 835
Dale H. Thiel, Reg. No. 24 323
David G. Boutell, Reg. No. 25 072
Ronald J. Tanis, Reg. No. 22 724

EXAMINER OCT 5 1981

By: David G. Boutell
David G. Boutell

Date: SEP 30 1981

DGB/9
Correspondence: Request for First Extension of Time

#3

Applicant : Kurt Stoll
Serial No.: 153 999
Filed : May 28, 1980
For : LINEAR MOTOR OPERABLE BY A PRESSURE MEDIUM

September 30, 1981
Group 212
Examiner D. Duggan

Honorable Commissioner of Patents and Trademarks
Washington, D. C. 20231

REQUEST FOR FIRST EXTENSION OF TIME

Sir:

It is respectfully requested that the shortened period for a response, now set to expire on October 2, 1981, be extended to November 2, 1981.

In support of this request, it is pointed out that the undersigned receives instructions from a German patent agent concerning the filing and prosecution of this application. The instructions were received on Monday, September 28, which instructions were in the German language. There remains insufficient time for a translation to be made available to the undersigned attorney of record and for him in turn to study the translation and prepare a response for filing before the due date of October 2, 1981.

In view of these circumstances, it is believed that additional time for filing a response is in order. Accordingly, granting of this request is respectfully solicited.

Respectfully submitted,

OCT 5 1981

By
David G. Boutell
Reg. No. 25 072

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, Clerk, Group 210
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GROUP 210

Applicant : Kurt Stoll
Serial No.: 153 999
Filed : May 28, 1980
For : LINEAR MOTOR OPERABLE BY A PRESSURE MEDIUM

Group 212
Examiner D. Duggan

Honorable Commissioner of Patents and Trademarks
Washington, D. C. 20231

CERTIFICATE OF MAILING

Sir:

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on November 2, 1981.

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Date: November 2, 1981

DGB/9
Correspondence: Response dated November 2, 1981

PATENT & TRADE MARK OFFICE 11 4 1981

Applicant : Kurt Stoll

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Group 212

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RECEIVED NOV 6 1981 GROUP 210

Honorable Commissioner of Patents and Trademarks

Washington, D. C. 20231

Sir:

In response to the Office Action mailed July 2, 1981 the shortened period for a response having been extended to November 2, 1981, Applicant amends as follows:

IN THE SPECIFICATION

Please change the title to ---MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER---.

Page 1, between the title and the first line of text; insert the subheading:

---FIELD OF THE INVENTION---.

between lines 2 and 3 of text; insert the subheading:

---BACKGROUND OF THE INVENTION---.

Page 5, between lines 7 and 8 of text; insert the subheading:

---BRIEF DESCRIPTION OF THE DRAWINGS---.

between lines 13 and 14 of text; insert the subheading:

---DETAILED DESCRIPTION---.

line 23; after "is" insert ---movably---.

line 24; change "passing along" to ---movably mounted on---.

Page 7, line 6; change "assomb-ly" to ---assembly---.

line 10; change "s" to ---a---.

line 14; change "12" to ---20---.

line 21; change "tetrafluoraethylene" to ---tetrafluoroethylene---.

Page 8, last line thereof; change "Gtriple" to ---triple---.

IN THE CLAIMS

Please cancel Claim 1 and substitute therefor the following:





In an arrangement having a hollow cylindrical tube and driving and driven members movable thereon for conveying articles, the improvement comprising wherein said tube is made of a nonmagnetic material, wherein said driving member is a piston movably mounted on the inside of said tube, said piston having a piston body and plural axially spaced, first permanent annular magnets encircling said piston body, said piston further including first means spacing said first permanent magnets in said axial spaced relation, the radially peripheral surface of said magnets being oriented close to the internal wall surface of said tube, said piston further including plural guide ring means encircling said piston body and slidingly engaging said internal wall and first sealing rings located axially outside said guide rings for wiping said internal wall as said piston moves along said tube to thereby cause any impurities that may be present in said tube to be pushed along said tube so that said first annular magnets will be free of interference from said impurities, wherein said driven member includes a cylindrical sleeve made of a magnetizable material and encircles said tube, said sleeve having plural axially spaced second permanent annular magnets affixed thereto and in magnetically attracting relation to said first permanent annular magnets and second means spacing said second permanent annular magnets in said axially spaced relation, the radially inner surface of said magnets being oriented close to the external surface of said tube, said sleeve having end face means with second sealing rings located axially outside said second permanent annular magnets for wiping the external wall surface of said tube as said driven member is moved along said tube in response to a driving movement of said piston to thereby cause any impurities that may be present on said tube to be pushed along said tube so that said second permanent

annular magnets will be free of interference from said impurities.

Please amend Claims 2 and 3 as follows:

-2- (Amended)

[A linear motor] The arrangement according to claim [1] ~~13~~, wherein [the wiping means of the] said sealing rings on said driven [assembly] member are formed as wiper rings which are seated in annular grooves opening inwardly on [radial] said end [walls] face means of [the] said driven assembly.

-3- (Amended)

[A linear motor] The arrangement according to claim [1 or 2] ~~13~~, wherein [the wiping means of the] said sealing rings on said driven assembly and [the] said sealing [means of the] rings on said piston lie in the same plane [transversal] perpendicular to the axis of [the tubular part] said tube.

Please cancel Claim 4 without prejudice.

Please amend Claim 5 as follows:

~~4~~ -5- (Amended)

[A linear motor] The arrangement according to [any of the preceding claims] claim ~~13~~, wherein [the tubular part] said tube is made of a thin [, stainless material such as] non-magnetic [special steel, brass or a plastics] material, and wherein water or a mixture of water and oil is used as the pressure medium.

Please cancel Claim 6 without prejudice.

Please amend Claim 7 as follows:

~~6~~ -7- (Amended)

[A linear motor] The arrangement according to [any of the preceding claims] claim ~~13~~, wherein [the wiping means and the] said sealing [means] rings are formed of a pliable, elastic material.





Please cancel Claim 8 without prejudice.

Please Claim 9 as follows:

~~8~~ -6- (Amended)

[A linear motor] The arrangement according to [any of the preceding claims] claim ~~13~~, wherein [the] said piston [has a] body is made of a non-magnetisable material.

Please cancel Claim ~~10~~ without prejudice.

Please amend Claim 11 as follows:

~~12~~ -7- (Amended)

[A linear motor] The arrangement according to [any of the preceding claims] claim ~~13~~, wherein [the] said piston [carries] has a flexible buffer at each end, the peripheral surface of which is spaced radially from the internal surface of [the tubular part] said tube.

Please cancel Claim ~~12~~ without prejudice.

In the Abstract of the Disclosure paragraph, please change the title to ---MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER---.

line 1; change "linear motor" to ---magnetically coupled arrangement for a driving and a driven member,---.

after "which" insert ---arrangement---.

REMARKS

Claims 1, 4, 6, 8, 10 and 12 have been cancelled. Claim 13 has been added. Accordingly, Claim 13 and the claims which depend therefrom, namely, Claims 2, 3, 5, 7, 9 and 11 remain in this application and Applicant respectfully requests consideration thereof.

Each of the claims now present in this application has been reviewed for compliance with the provisions of Title 35 USC 112. Accordingly, further consideration of these claims, particularly with respect to the provisions of Title 35 USC 112, is respectfully solicited.

Applicant wishes to make of record German Offenlegungsschrift No. 27 37 924 and German Gebrauchsmuster No. 19 82 379. These references were cited in the first Office Action received

in the corresponding German application. These references are obviously clearly distinguishable over the subject matter of the claims now present in this application. Accordingly, further comment about the subject matter of these references is believed unnecessary. It is clear that neither of these two references discloses the use of structure preventing the interference by impurities located inside the tube and on the outside of the tube while the arrangement is moved along the tube.

Accordingly, and based upon the foregoing comments, further and favorable consideration of this application is respectfully solicited.

Respectfully submitted,

By _____
David G. Boutell
Reg. No. 25 072

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DE-Gm 19 82 379

Dipl.-Ing. Kurt Stoll, Esslingen a. N.

Förderrichtung zum Transportieren des Förderguts zwischen einer Aufgabestelle(n) und gegebenen Tod- oder Zwischenstellungen

Die Erfindung betrifft eine mit Hilfe eines Druckmediums als Bewegungsträger, z. B. einer pneumatischen oder hydraulischen Medium betriebene Förderrichtung zum Transportieren des Förderguts zwischen einer Aufgabestellung und gegebenen Tod- oder Zwischenstellungen.



Anordnungen der hier in Frage stehenden Art werden z. B. als aufgeständerte Schwerkraftrutschen, Schwerkraftförderer, pneumatische Transportvorrichtungen usw. verwendet.

Die bekannten Anordnungen der vorgenannten Art haben einen komplizierten, mit großen Herstellungskosten verbundenen Aufbau und neben darüber hinaus einen relativ großen Aufwand an Platzbedarf erforderlich. Z.B. auch aus diesen Gründen ist die Anwendung dieser bekannten Anordnungen beschränkt. Das Ziel der Erfindung besteht darin, hier Abhilfe zu schaffen.



Zu den oben genannten Zweck besteht somit der Erfindung die neue Förderrichtung eines in einer Rohr oder Trogoder Arbeitszylinder geführten der Aufgabestellung und der Endstellung unter Wirkung des Druckmediums als und der beweglich geführten selbstabdichtenden Kolben und eine angetrieb des Rohres oder Trog- oder Arbeitszylinders gerichtet, mit dem Kolben in zugeordneter Kraft- und Wirkverbindung stehende und dieser mit diesem bis auf der beweglichen Halterung für den Förderguß. Die neue Vorrichtung zum Betrieb z. B. einen unter Einbringung des Druckmediums als und der beweglichen Kolben, ein den Kolben entsprechender und führender und Betrieb in der Art eines unter- oder Arbeitszylinders wirkendes Förderaggregat aus einer Material als Ein- und Auslassen für das Druckmedium, einer

Fig. 7 eine Abwandlung des Gegenstandes der Erfindung in einer Draufsicht in schematischer Darstellung und

Fig. 8 eine Variante zu der Anordnung nach Fig. 7 ebenfalls in einer Draufsicht in schematischer Darstellung.

Die erfindungsgemäße Anordnung enthält als wichtigste Teile einen Kolben 1, der unter Einwirkung des Druckmediums - Druckluft oder Druckflüssigkeit - gemäß Pfeil 2 hin und her beweglich ist, und ein Führungsrohr 3, das den Kolben enthält und führt und hierbei in der Art eines Druck- oder Arbeitszylinders wirkt und das demzufolge nicht weiter dargestellte Einlässe und Auslässe für das Druckmedium besitzt. Außerdem enthält die erfindungsgemäße Vorrichtung einen Innenmagneten 4, der mit dem Kolben fest verbunden ist und von innen her an der Rohrinnenwandung entlang berührungsfrei geführt ist, sowie einen Außenmagneten 5, der von außen her an der Rohraußenwandung entlang berührungsfrei geführt ist und dank der magnetischen Kraftverbindung zwischen ihm und dem Kolben mit diesem am Führungsrohr entlang beweglich ist. Mit dem Außenmagneten ist eine mit ihm hin und her bewegliche Halterung 6 für das Fördergut vorgesehen, die am Führungsrohr z. B. unter rollender Reibung geführt ist.





Bei der Ausführungsform nach Fig. 1 bis 3 besteht der Kolben 1 aus einem Kern 1a, der z. B. aus nichtmagnetisiertem Material, z.B. Kunststoff hergestellt werden kann, und aus Dichtungsringen 1b, 1c, die mit ihrer Aussenfläche oder Umfläche an der Rohrinnenwand anliegen und zum dichten Abschließen des Raumes 7 von Raum 8 innerhalb des Führungsrohres 3 dienen. Der Kolben trägt einen Innenmagneten 4, der in diesem Falle als Magnetring ausgebildet ist. Der Innenmagnet kann jedoch auch als magnetisches Formstück ausgebildet sein, wie z.B. bei 9 in Fig. 4a gezeigt ist. In diesem letzteren Falle ist der Kolben an der Innenwand des Führungsrohres mit Hilfe von mehreren Führungsrollen, z.B. drei Führungsrollen 10a, 10b, 10c gelagert, deren Drehachsen 11a, 11b, 11c quer zur Rohrlängsachse und unter einem Winkel zueinander verlaufen und die sich mit ihrem Umfang an der Rohrinnenwand abstützen. Diese Führungsrollen 10a, 10b, 10c sind am Kolben 12 so drehbar gelagert, daß ihre Längsmittelebenen sternartig zueinander verlaufen (Fig. 4 a ) und hierbei jeweils einen Winkel von 120° miteinander bilden, wobei ihre Drehachsen nicht in einer einzigen gemeinsamen Ebene enthalten sind (Fig. 4 b). Bei der Anordnung nach Fig. 1 bis 3 ist der als langliches prismatisches Formstück ausgebildete Kolben im Bereich seiner beiden axialen Enden jeweils mit einem elastischen Dichtungsring 1b, 1c aus Gummi oder Kunststoffmaterial versehen, der







mit dem Kolben fest verbundenen und innen entlang der Rohrinnenwandung berührungsfrei geführten Innenmagneten, einen außen an der Außenwandung des Führungsrohres entlang in deren den Innenmagneten entsprechenden Bereich hin und her beweglich geführten Außenmagneten und eine zusammen mit dem Außenmagneten hin und her bewegliche Halterung für das Fördergut enthalten. Die erfindungsgemäße Anordnung, die sich durch einen denkbar einfachen Aufbau auszeichnet, macht es möglich, den Raumaufwand auf praktisch die Hälfte des Aufwandes bei üblichen bekannten Anordnungen herabzusetzen. So z.B. ist bei aufzugartigen Vorrichtungen, Hubtischen usw. nur noch eine der Hublänge entsprechende Einbaulänge erforderlich, während bei den bekannten vergleichbaren Anordnungen die Einbaulänge etwa doppelt so groß wie die Hublänge ist, weswegen man in diesen Fällen manchmal den Antriebszylinder in den Boden eingräbt. Mit der erfindungsgemäßen Anordnung wird der Anwendungsbereich von pneumatischen oder hydraulischen Arbeitszylindern in Fällen der oder in Frage stehenden Art wesentlich erweitert, da man nunmehr mit überlangen Kolbenstangen, z.B. von 10 m und mehr arbeiten kann, ohne Instabilität zu befürchten, während bei bekannten Anordnungen eine Kolbenstangenlänge von maximal 2 - 3 m möglich ist. Die Halterung der erfindungsgemäßen Anordnung ist auch an Kurven bewegbar, wobei die Führung einfach ist, während bei Hängeförderern im Falle von Kurven eine seitliche Reibung des ziehenden Elementes auftritt.





In der Zeichnung sind Ausführungsbeispiele des Gegenstandes der Erfindung dargestellt. Es zeigen:

Fig. 1 eine erste Ausführungsform des Gegenstandes der Erfindung in einer Seitenansicht in Teildarstellung in einem senkrechten Schnitt,

Fig. 2 die Anordnung nach Fig. 1 in einem Schnitt gemäß der Linie II-II der Fig. 1,

Fig. 3 die Anordnung nach Fig. 1 in einem Schnitt gemäß der Linie III-III der Fig. 1,

Fig. 4 a eine abgewandelte Ausführungsform des Gegenstandes der Erfindung in einer Darstellungsweise entsprechend derjenigen nach Fig. 2,

Fig. 4 b die Anordnung nach Fig. 4 a in einer Seitenansicht,

Fig. 5 eine abgewandelte Ausführungsform des Gegenstandes der Erfindung in einer Darstellungsweise entsprechend derjenigen nach Fig. 3,

Fig. 6 eine weitere Variante des Erfindungsgegenstandes in Teildarstellung in einem senkrechten Schnitt,

durch aus, daß eine wesentlich größere magnetische Kraft aufgewendet werden kann. Das neue System könnte in Übrigen auch in senkrechter Richtung arbeiten.

Das Trag- und Führungsrohr besteht zweckmäßigerweise aus Kunststoffmaterial oder z.B. auch aus Messing, also insgesamt aus einem nicht magnetischen Werkstoff.

Man kann die Innen- und/oder Außenmagnete als Permanentmagnete ausführen, man kann sie jedoch auch als Elektromagnete einstellbarer Stärke ausbilden. Schließlich kann man die Innen- und/oder Außenmagnete auch aus einer permanentmagnetischen Partie und einer ganz oder teilweise beliebig zu- und abschaltbaren elektromagnetischen Partie herstellen. Diese letztere Variante des Erfindungsgegenstandes gibt die Möglichkeit, die magnetische Kraft den jeweiligen Erfordernissen anzupassen.

Das Trag- und Führungsrohr kann gemäß Fig. 7 geradlinig verlaufen, derart, daß die Bewegungsbahn der Halterung für das Fördergut zwischen der Ausgangsstellung A und der Endstellung B in gerader Richtung gemäß Pfeil 25 verläuft (Fig. 7). Die Bewegungsbahn kann jedoch auch gekrümmt sein. Im Extremfall kann sie gemäß der Anordnung nach Fig. 8 die Form eines Kreises oder einer Ellipse haben, derart, daß die Halterung für das Fördergut sich entlang am ellipsenartig geformten Trag- und Führungsrohr 26, also entlang einer endlosen Bahn bewegen kann.





## Ansprüche

1. Mit Hilfe eines Druckmediums als Bewegungserzeuger, z. B. eines pneumatischen oder hydraulischen Mediums, betriebene Fördervorrichtung zum Transportieren des Fördergutes zwischen einer Ausgangsstellung und gegebenen End- oder Zwischenstellungen, dadurch gekennzeichnet, daß sie einen in einem Rohr oder Druck- oder Arbeitszylinder zwischen der Ausgangsstellung und der Endstellung hin und her beweglich geführten kolbenstangenlosen Kolben und eine außerhalb des Rohres oder Druck- oder Arbeitszylinders geführte, mit dem Kolben in magnetischer Kraft- und Wirkverbindung stehende und hierbei mit diesem hin und her bewegliche Halterung für das Fördergut besitzt.

2. Fördervorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß sie einen unter Einwirkung des Druckmediums hin und her beweglichen Kolben, ein den Kolben enthaltendes und führendes und hierbei in der Art eines Druck- oder Arbeitszylinders wirkendes Führungsrohr aus nicht-magnetischem Material mit Ein- und Auslassen für das Druckmedium, einen mit dem Kolben fest verbundenen und innen entlang der



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mit seinem Außenumfang an der Rohrinnenwand anliegt. Der Kolben trägt zwischen seinen Enden den ringartig ausgebildeten Innenmagneten 4.

Bei der Anordnung nach Fig. 1 bis 3 ist der Außenmagnet 5 als magnetisches Formstück ausgebildet, dessen dem Führungsrohr 3 zugewandte wirksame Fläche p a den zugeordneten Abschnitt des Rohrumfangs entsprechend ausgebildet und hierbei nach dem Magnetinneren gewölbt oder segmentartig ausgeschnitten ist. Eine solche Ausbildung des Aussenmagneten ist auch bei den Magneten 13 der Anordnung nach Fig. 4 a, 4b gezeigt. Der Außenmagnet kann jedoch auch als das Führungsrohr in koaxialer Anordnung umgebender Ring ausgebildet sein. So kann er als ein nicht völlig geschlossener Ring ausgebildet sein, wie er bei 14 dargestellt ist, der sich z.B. nur über 3/4 des Umfangs des Führungsrohres 15 erstreckt. Gemäß Fig. 6 kann der Außenmagnet auch als völlig geschlossener Ring 16 ausgebildet sein, der das Führungsrohr 17 ganz umschließt. Während bei der Anordnung nach Fig. 5 Platz für Halterungen des Führungsrohres innerhalb der Bewegungsbahn des Magneten vorhanden ist, vgl. z.B. die Halterungen 18 in Fig. 5 oder die Halterung 19 in Fig. 3, ist die Anordnung gemäß Fig. 6 für Fälle gedacht, bei denen das Führungsrohr, das sich nur über eine kurze axiale Länge erstreckt, an seinen beiden Enden gehaltert ist, wobei die Transportbewegung zwischen diesen beiden Enden stattfindet, so daß die Halterungen die





Bewegung des Außenmagneten 16 in keiner Weise stören. Bei den Anordnungen nach Fig. 5 und 6 ist im übrigen der Innenmagnet ebenfalls als völlig geschlossener Ring 20 bzw. 21 ausgebildet.

Bei der Anordnung nach Fig. 1 bis 3 ist die Halterung 6 als an Führungsrohr 3 verschieblich geführtes Formstück ausgebildet, dessen mittlerer Bereich den Außenmagneten 5 trägt und das mit der Lastaufnahme verbunden ist. Die Last wirkt in diesem Falle gemäß Pfeil 22. Diese Halterung 6 ist an Führungsrohr mit Hilfe von zwei Rollen 23a, 23b gelagert, die drehbar sind und sich mit ihren profilierten Außenumfang an Führungsrohr 3 abstützen. Bei der Anordnung nach Fig. 5 hingegen ist das Anbringen von solchen Führungsrollen als tragendes Element nicht erforderlich, da der Innenring und der Außenring koaxial ineinander gelagert und somit selbstzentrierend angeordnet sind, derart, daß der Luftspalt zwischen ihnen an allen Seiten annähernd gleich ist. Es findet somit keine Reibung während der Bewegung statt. Aus diesem Grunde dienen die Rollen 24a, 24b bzw. die Rollenpaare, die jeweils Rollen 24a, 24b enthalten, nicht als Abstützrollen, wie bei der Ausführungsform nach Fig. 1 bis 3, sondern nur noch als Tragrollen für die Last. Diese Anordnung, bei der das Führungsrohr 15 einerseits als Führungselement und andererseits als tragendes Element wirkt und darüber hinaus beim Antrieb mitwirkt, zeichnet eine da-



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10. Fördervorrichtung nach Anspruch 8 oder 9, dadurch gekennzeichnet, daß der vorteilhaft länglich prismatische Kolben in den Bereichen seines vorderen und seines hinteren axialen Endes jeweils einen Dichtungsring trägt, der mit seiner äußeren Umfläche an der Rohrinnenwand anliegt.

11. Fördervorrichtung nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß der als vorteilhaft länglich-prismatisches Formstück ausgebildete Kolben in Bereich seiner beiden axialen Enden jeweils einen mit seinem Außenumfang an der Rohrinnenwand anliegenden Dichtungsring, z.B. aus Gummi oder Kunststoffmaterial und zwischen seinen Enden den ringartig ausgebildeten Innenmagneten trägt.

12. Fördervorrichtung nach einem der Ansprüche 1 bis 11, dadurch gekennzeichnet, daß die Halterung am Führungsrohr unter rollender Reibung geführt ist.

13. Fördervorrichtung nach Anspruch 12, dadurch gekennzeichnet, daß die Halterung als am Führungsrohr mit Hilfe von zwei im Bereich ihres vorderen und ihres hinteren Endes drehbar gelagerten Führungsrollen oder Führungsrollenpaaren verschieblich geführtes Formstück ausgebildet ist, dessen mittlerer Bereich den Außenmagneten trägt und mit der Lastaufnahme verbunden ist.





14. Fördervorrichtung nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Halterung am Führungsrohr führungsrollenlos allein unter Wirkung des entwickelten magnetischen Kraftflusses geführt ist.

15. Fördervorrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß der Innen- und/oder Außenmagnet als Permanentmagnet ausgebildet ist.

16. Fördervorrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß der Innen- und/oder Außenmagnet als Elektromagnet einstellbarer Stärke ausgebildet ist.

17. Fördervorrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß der Innen- und/oder Außenmagnet aus einer permanentmagnetischen Partie und einer ganz oder teilweise beliebig zu- und abschaltbaren elektromagnetischen Partie besteht.

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Führungsrohres erstreckender magnetischer Ring ausgebildet ist.

7. Fördervorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Außenmagnet als das Führungsrohr in koaxialer Anordnung umschließender, völlig geschlossener Ring ausgebildet ist.

8. Fördervorrichtung nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß der Kolben in seinem mittleren Bereich den Innenmagneten trägt und im übrigen an der Innenwand des Führungsrohres mit Hilfe von mehreren, z.B. drei Führungsrollen verfahrbar gelagert ist, deren Drehachsen einerseits etwa quer zur Rohrlängsachse und andererseits unter einem Winkel zueinander verlaufen und die sich mit ihren Umfang an der Rohrinnenwand abstützen.

9. Fördervorrichtung nach Anspruch 8, dadurch gekennzeichnet, daß am Kolben drei Führungsrollen drehbar gelagert sind, deren Längsmittelebenen sternartig zueinander verlaufen und hierbei jeweils einen Winkel von 120° miteinander bilden, wobei zweckmäßig ihre Drehachsen nicht in einer einzigen gemeinsamen Ebene enthalten sind.





Rohrinnenwandung berührungsfrei geführten Innenmagneten, einen außen an der Außenwandung des Führungsrohres entlang in deren dem Innenmagneten entsprechenden Bereich hin und her beweglich geführten Außenmagneten und eine zusammen mit den Außenmagneten hin und her bewegliche Halterung für das Fördergut enthält.

3. Fördervorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Innenmagnet als Magnetring ausgebildet ist.

4. Fördervorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Innenmagnet als magnetisches Formstück ausgebildet ist.

5. Fördervorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Außenmagnet als magnetisches Formstück ausgebildet ist, dessen dem Führungsrohr zugewandte wirksame Fläche dem zugeordneten Abschnitt des Rohrumfangs entsprechend ausgebildet, z.B. nach dem Magnetinneren zu gewölbt oder segmentartig ausgeschnitten ist.

6. Fördervorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Außenmagnet als ein das Führungsrohr in koaxialer Anordnung umgebender, nicht völlig geschlossener, sich z.B. nur über 3/4 des Umfangs des



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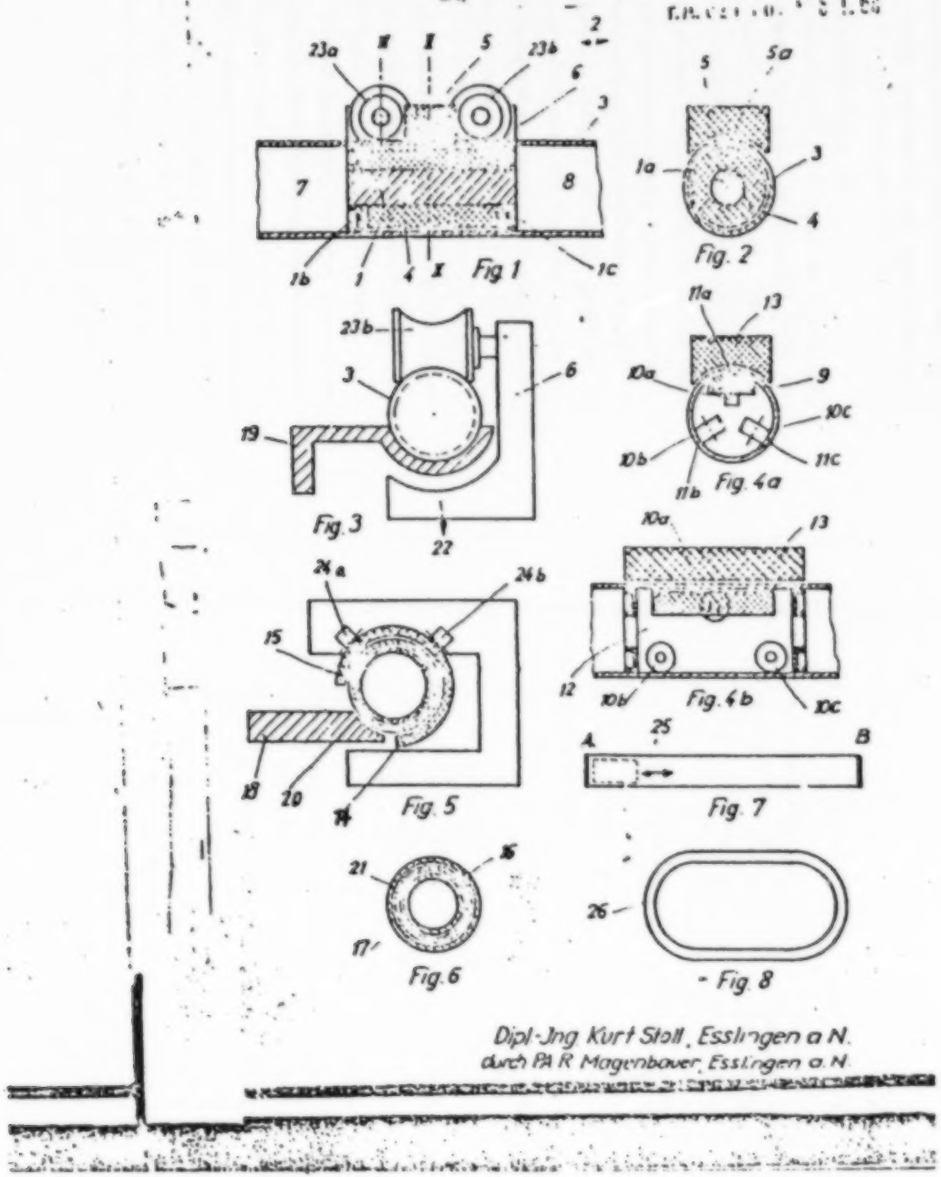




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Festo-Maschinenfabrik Gottlieb Stoll, 7300 Esslingen

# Rohrpostartige Transportvorrichtung

## Ansprüche

1. Rohrpostartige Transportvorrichtung mit einem Rohr, in dem ein kolbenartiges Teil mit Hilfe eines vorzugsweise pneumatischen Druckmediums zwischen einer Ausgangsstellung und gegebenen Zwischen- und/oder Endstellungen hin und her bewegbar ist, wobei die zu transportierende Last mit bewegt wird, dadurch gekenn-

zeichnet, daß am Aussenumfang des aus unmagnetischem Material hergestellten Rohres (12) ein Wagen (21) hin und her bewegbar geführt ist und daß das kolbenartige Teil (13) und der Wagen (21) einen Innen- bzw. Aussenmagneten (17,27) besitzen, welche Magnete eine Bewegungskopplung der beiden bewegbaren Teile bewirken.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Magnete (17,27) bezüglich der Rohrwandung berührungsfrei geführt sind.

3. Vorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Innen- oder Aussenmagnet (17,27) als geschlossener oder einseitig geschlitzter Magnetring (17,27) ausgebildet ist bzw. sind, wobei die Magnetringe koaxial zueinander sind.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Wagen (21) als einseitig geschlitzter Ring ausgebildet ist und über den Umfang gleichmäßig verteilt vorzugsweise drei Laufrollenpaare (22,23) besitzt.

5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß der Wagen (21) oben- oder untenseitig mit einer Halterung (21) für die zu transportierende Last (28) versehen ist.





6. Vorrichtung nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß der Wagen (21) in einem Umfangsbereich geschlitzt ist, in dem Stützen (14) am Rohr (12) angreifen.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das kolbenartige Teil (13) beidendig mit an der Rohrinnenwandung anliegenden, radial wirkenden Ringdichtungen (18) versehen ist.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Magnete (17,27) als Permanent- und/oder einstellbare Elektromagnete ausgebildet sind.

10.August 1977

D 5578- fual

Festo-Maschinenfabrik Gottlieb Stoll, 7300 Esslingen

---

# Rohrpostartige Transportvorrichtung

---

Die Erfindung bezieht sich auf eine rohrpostartige Transportvorrichtung mit einem Rohr, in dem ein kolbenartiges Teil mit Hilfe eines vorzugsweise pneumatischen Druckmediums zwischen einer Ausgangsstellung und gegebenen Zwischen- und/oder Endstellungen hin und her bewegbar ist, wobei die zu transportierende Last mitbewegt wird.

Bei den bekannten sogenannten Rohrpostvorrichtungen sind verschließbare Hülsen vorgesehen, in die der zu transportierende Gegenstand eingesteckt wird und die dann





mittels eines pneumatischen Druckmediums in ihre andere Endstellung transportiert werden. Diese Vorrichtungen haben den Nachteil, daß die zu transportierenden Gegenstände volumenmäßig sehr begrenzt sind. Darüber hinaus ist das Öffnen und Schließen der Transporthilfe relativ zeitraubend und umständlich, Solche Rohrpostvorrichtungen werden deshalb nur zum Transport von Papieren u.dgl. über relativ lange Wege eines Gebäudes verwendet. Für kurze Wege und zum Transport von schwereren und größeren Lasten, beispielsweise zur innerbetrieblichen Förderung von Arbeitsplatz zu Arbeitsplatz sind Vorrichtungen bekannt, die beispielsweise mit Hilfe eines pneumatischen Zylinders oder mit Hilfe einer Kette über einen Antriebsmotor angetrieben werden. Pneumatische Zylinder haben jedoch den Nachteil, daß sie nur etwa bis zu einem Hub von 2 m wirtschaftlich einsetzbar sind. Kettenantriebe und ähnliche Vorrichtungen haben den Nachteil, daß sie sehr geräuschvoll arbeiten.

Eine Aufgabe der vorliegenden Erfindung ist es, eine rohrpostartige Transportvorrichtung der eingangs genannten Art zu schaffen, mit der relativ große Gegenstände problemlos, beispielsweise für den innerbetrieblichen Ablauf, hin und her befördert werden können.

Zur Lösung dieser Aufgabe ist erfindungsgemäß vorgesehen, daß am Umfang des aus unmagnetischem Material hergestellten Rohres ein Wagen hin und her bewegbar geführt ist und daß das kolbenartige Teil und der Wagen einen Innen- bzw.

Aussenmagneten besitzen, welche Magnete eine Bewegungskopplung der beiden bewegbaren Teile bewirken.

Die erfindungsgemäße Vorrichtung kann also einen ähnlich unkomplizierten Aufbau wie eine Rohrpostvorrichtung besitzen, ist aber hinsichtlich der zu transportierenden Gegenstände und Lasten praktisch nicht beschränkt. Die erfindungsgemäße Vorrichtung kann man beispielsweise zur innerbetrieblichen Förderung von Arbeitsplatz zu Arbeitsplatz einsetzen, beispielsweise in Form eines Schrägaufzuges oder in anderer Weise. Sie ist ferner geräuscharm und stellt sich im Gegensatz zur bekannten Rohrpost als vom pneumatischen Antriebsmedium her geschlossenes System dar, so daß sie einen denkbar einfachen Aufbau besitzen kann und keine Abdichtungsprobleme bestehen.

Weitere Einzelheiten und Ausgestaltungen der Erfindung sind der folgenden Beschreibung zu entnehmen, in der die Erfindung anhand des in der Zeichnung dargestellten Ausführungsbeispieles näher beschrieben und erläutert wird. Es zeigen:

Fig. 1 einen Querschnitt durch die Transportvorrichtung gemäß einem Ausführungsbeispiel vorliegender Erfindung und

Fig. 2 einen Längsschnitt durch die Transportvorrichtung nach Fig. 1.





Die erfindungsgemäße rohrpostartige Transportvorrichtung 11 besitzt ein Rohr 12 aus einem unmagnetischen Material, innerhalb dem ein kolbenartiges Teil 13 gemäß Pfeil A unter der Einwirkung eines hydraulischen oder pneumatischen Druckmediums, vorzugsweise Druckluft, hin und her bewegbar ist. Das Führungsrohr 12, das einen relativ kleinen Innendurchmesser von etwa 25 mm besitzen kann, kann nahezu jede beliebige Art der Wegführung besitzen. Es kann also beispielsweise längs einer geraden Strecke, längs einer Schleife, eben, geneigt oder in sonstiger Weise geführt und ausgebildet sein. Bei längeren Wegstrecken ist es zweckmäßig, wie aus Fig. 2 ersichtlich, das Führungsrohr 12 in konstantem Abstand durch eine Stütze 14 abzustützen.

Das kolbenartige Teil 13 besitzt einen Kern 16 aus unmagnetischem Material, um den ein Magnetring 17 angeordnet ist. An beiden Stirnenden des Magnetrings 17 ist der Kern 16 von radial wirkenden Ringdichtungen 18 umgeben, die sich dichtend an die Innenwandung des Rohrs 12 anlegen und gleichzeitig zur Führung des Teils 13 dienen. Die Anordnung der einzelnen Elemente des Teiles 13 ist dabei so getroffen, daß der Magnetring 17 zur Innenwandung des Rohrs 12 einen kleinen Ringspalt besitzt, also berührungsfrei innerhalb des Führungsrohres 12 gehalten ist. Der Kern 16 bildet an seinen beiden Stirnseiten 19 die Angriffsfläche für das vorzugsweise pneumatische Druckmedium.

Aussenumfangsseitig ist das Führungsrohr 12 von einem Wagen 21 umgeben, der die Form eines geschlitzten Ringes besitzt und ebenfalls aus unmagnetischem Material hergestellt ist. Der Wagen 21 besitzt an drei vorzugsweise in konstantem Abstand angeordneten Umfangsbereichen eine vordere und eine hintere Lauf- und Führungsrolle 22,23, mit denen der Wagen 21 längs des Rohres 12 leicht verfahrbar ist. Die Rollen 22,23 sind radial gerichtet, wobei ihre Drehachsen 24 quer zur Bewegungsrichtung angeordnet sind. Im Umfangsbereich der am Rohr 12 angreifenden Stützen 14 ist der Wagen 21 mit einem Schlitz 26 versehen, der vorzugsweise schräg nach unten, vorzugsweise spitzwinklig zur Senkrechten verläuft. Innenumfangsseitig ist am Wagen 21 ein äußerer Magnetring 27 gehalten, der koaxial zum Innenmagnetring 17 angeordnet ist und zu diesem den Gegenmagneten darstellt. Auch der Aussenmagnetring 27 ist derart gehalten, daß sein Innenumfang mit dem Aussenumfang des Rohres 12 einen Spalt bildet, so daß er bezüglich des Rohres 12 berührungsfrei gehalten ist. Beim dargestellten Ausführungsbeispiel wird die Last 28 mittels einer geeigneten Haltevorrichtung 29 nach unten hängend am Wagen 21 gehalten bzw. befestigt. Es versteht sich, daß eine entsprechende Halte- oder Aufnahmevorrichtung auch oben, seitlich oder an einem anderen beliebigen Umfangsbereich des Wagens 21 vorgesehen sein kann. Es ist auch möglich, eine oder zwei Haltevorrichtungen stirnseitig am Wagen anzubringen..





Die beiden Magnetringe 17 und 27 sind derart aufeinander abgestimmt, daß sich eine praktisch bewegungsstarre Kopplung des Wagens 21 mit dem pneumatisch angetriebenen Teil 23 ergibt, so daß der Wagen 21 synchron mit dem Antrieb des Innenteils 13 durch beispielsweise Druckluft hin und her verfahren wird. Die Innen- und/oder Aussenmagnete 17,27 können als Permanentmagnete oder auch als Elektromagnete mit einstellbarer Stärke ausgebildet sein. Es ist auch möglich, Permanent- und Elektromagnete miteinander derart zu kombinieren, daß die Grundlast von Permanentmagneten übernommen wird, während für andere Fälle Elektromagnete beliebig zu- und abgeschaltet werden.

Es versteht sich, daß es auch möglich ist, den Magneten 17 und 27 eine andere Form zu geben. Beispielsweise ist es möglich, statt eines Ringes mehrere über den Umfang verteilt angeordnete Magnete vorzusehen. Es ist ferner auch möglich, dem Wagen 21 eine andere Form zu geben, beispielsweise ihn galgenförmig an das Rohr anzuhängen.

Es versteht sich ferner, daß das Führungsrohr 12 als geschlossenes System ausgebildet ist, das beid-endig mit Ein- und Auslaßöffnungen für das Druckmedium versehen ist. Es ist auch möglich, je nach Länge des Führungsrohres an Zwischenstationen absperrbare Ein- und Auslässe für das Druckmedium vorzusehen.

T11

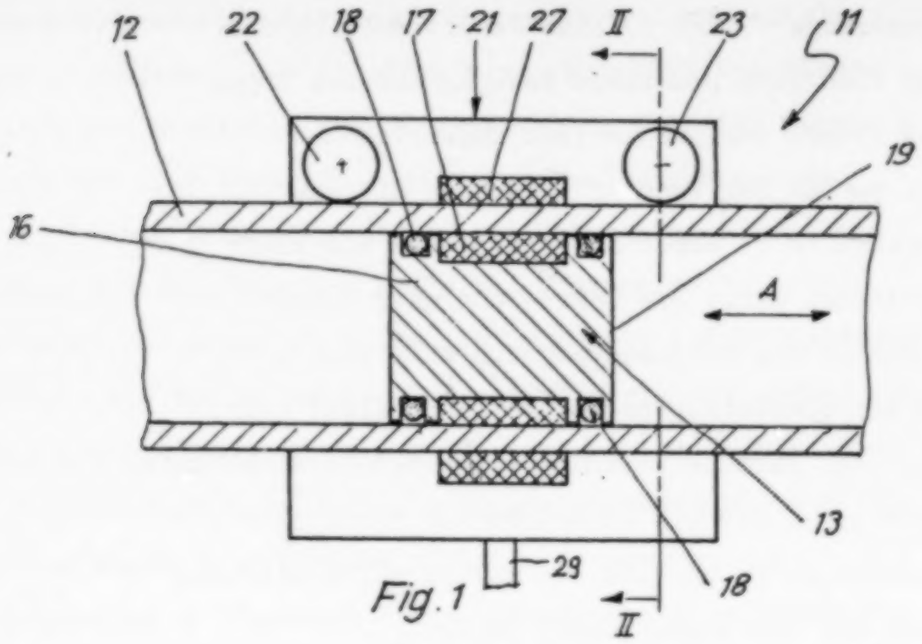


Fig. 1

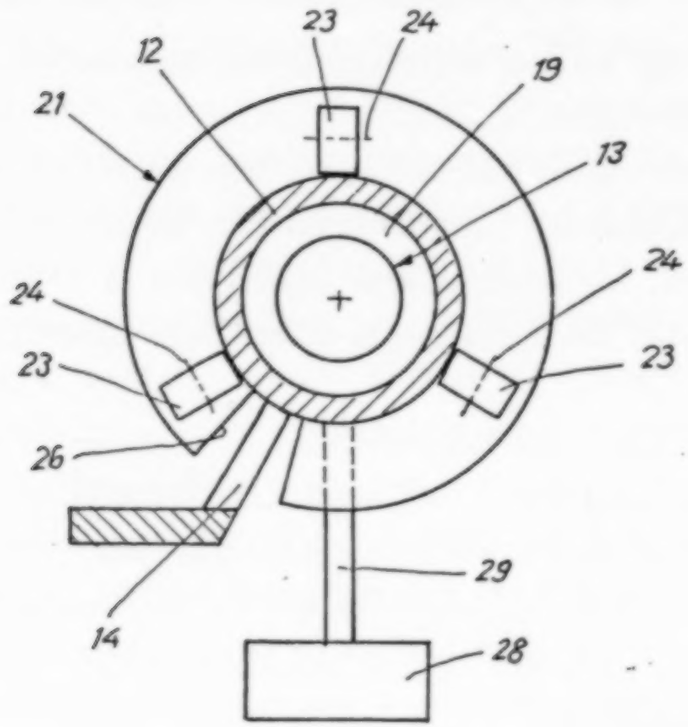


Fig. 2

055481



**UNITED STATES DEPARTMENT OF COMMERCE**
**Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

| SERIAL NUMBER | FILING DATE | FIRST NAMED APPLICANT | ATTORNEY DOCKET NO. |
|---|---|---|---|
| 16/153,999 | 05/29/80 | STOLL R | PKR CASE 28 |

BLANCHARD, FLYNN, THIEL,
BOUTELL & TANTS
2026 RAMBLING RD.
KALAMAZOO, MI 49008

| EXAMINER | |
|---|---|
| DUGGAN, D | |
| ART UNIT | PAPER NUMBER |
| 212 | 5 |

DATE MAILED: 11 MAR 1982

This is a communication from the examiner in charge of your application.

COMMISSIONER OF PATENTS AND TRADEMARKS

☐ This application has been examined. ☑ Responsive to communication filed on 11/4/82 ☐ This action is made final.

A shortened statutory period for response to this action is set to expire 2 month(s), — days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

**Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:**

1. ☑ Notice of References Cited by Examiner, PTO-892
2. ☐ Notice of Informal Patent Drawing, PTO-948
3. ☐ Notice of References Cited by Applicant, PTO-1449
4. ☐ Notice of Informal Patent Application, Form PTO-152
5. ☐ _____

**Part II SUMMARY OF ACTION**

1. ☑ Claims 13, 2, 3, 5, 7, 9, 11 are pending in the application.
   Of the above, claims _____ are withdrawn from consideration.
2. ☐ Claims _____ have been cancelled.
3. ☑ Claims 13, 2, 3, 5, 7, 9, 11 are allowed.
4. ☐ Claims _____ are rejected.
5. ☑ Claims 13, 2, 3, 5, 7, 9, 11 are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☐ The formal drawings filed on _____ are acceptable.
8. ☐ The drawing correction request filed on _____ has been ☐ approved. ☐ disapproved.
9. ☐ Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has
   ☐ been received. ☐ not been received. ☐ been filed in parent application, serial no. _____,
   filed on _____.
10. ☒ Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
11. ☐ Other

PTOL 326 (rev. 7-78)

**EXAMINER'S ACTION**

This application appears to be in condition for allowance except for the following formal matters, all references to "linear motors" in the specfification should be deleted inasmuch as such nomenclature connotes a different device having different operational characteristics.

The cited references are believed of interest.

Prosecution as to the merits is closed in accordance with the practice under ex parte Quayle, 1935 C.D. 11, 453 O.G. 213.

A SHORTENED STATUTORY PERIOD FOR RESPONSE TO THIS ACTION IS SET TO EXPIRE TWO MONTHS FROM THE DATE OF THIS LETTER.

Duggan:go

703/557/5050

2/10/82

DONOVAN F. DUGGAN
PRIMARY EXAMINER
ART UNIT 212



MAR 23 1982

MAR 30 1982

Applicant : Kurt Stoll

Serial No.: 153 999 Group 212

Filed : May 28, 1980 Examiner D. Duggan

For : MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER

Honorable Commissioner of Patents and Trademarks

Washington, D. C. 20231

CERTIFICATE OF MAILING

Sir:

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on

March 22, 1982.

BLANCHARD, FLYNN, THIEL, BOUTELL & TANIS, P.C.

Raywood H. Blanchard, Reg. No. 16 383
L. Martin Flynn, Reg. No. 17 835
Dale H. Thiel, Reg. No. 24 323
David G. Boutell, Reg. No. 25 072
Ronald J. Tanis, Reg. No. 22 724

By: David G. Boutell
David G. Boutell, Reg. No. 25 072

Date: March 22, 1982

Correspondence: Response dated March 22, 1982.

Applicant : Kurt Stoll
Serial No.: 153 999
Filed : May 28, 1980
For : MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER

March 22, 1982
Group: 212
Examiner: D. Duggan

Honorable Commissioner of Patents and Trademarks
Washington, D. C. 20231

Sir:

In response to the Office Action mailed March 11, 1982, Applicant amends as follows:

IN THE SPECIFICATION

Page 1, line 2; change "linear motor" to ---magnetically coupled arrangement---
line 5; change "Linear motors" to ---Magnetically coupled arrangements---
line 11; change "linear motor" to ---magnetically coupled arrangement---
Page 2, line 14; change "linear motor" to ---magnetically coupled arrangement---
Page 5, line 1; change "linear motor" to ---magnetically coupled arrangement---
line 4; change "linear motor" to ---magnetically coupled arrangement---
line 12; change "linear motor" to ---magnetically coupled arrangement---
line 16; change "linear motor" to ---magnetically coupled arrangement---
Page 7, line 6,7; change "linear motor" to ---magnetically coupled arrangement---
Page 8, line 21; change "linear motor" to ---magnetically coupled arrangement---
Page 9, line 15; change "linear motor" to ---magnetically coupled arrangement---

REMARKS

Applicant acknowledges with thanks the allowance of Claims 13, 2, 3, 5, 7, 9, and 11. The foregoing amendment to the specification deletes all references to "linear motors"





and replaces same with "magnetically coupled arrangements". Accordingly, it is respectfully submitted that the issues in this application have all been resolved.

Accordingly, issuance of the formal Notice of Allowance is respectfully solicited.

Respectfully submitted,

BLANCHARD, FLYNN, THIEL,
BOUTELL & TANIS, P.C.

David G. Boutell
Reg. No. 25 072
2026 Rambling Road
Kalamazoo, Michigan 49008

DGB/5

Encl. Postal Card

**UNITED STATES DEPARTMENT OF COMMERCE**
**Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

# NOTICE OF ALLOWANCE AND BASE ISSUE FEE DUE

BLANCHARD, FLYNN, THIEL,
BOUTELL & TANTR
2026 RAMBLING RD,
KALAMAZOO, MI 49008

All communications regarding this application should give the serial number, date of filing, name of applicant, and batch number.

Please direct all communications to the Attention of "OFFICE OF PUBLICATIONS" unless advised to the contrary.

The application identified below has been examined and found allowable for issuance of Letters Patent. PROSECUTION ON THE MERITS IS CLOSED.

| | SC/SERIAL NO. | FILING DATE | TOTAL CLAIMS | DATE MAILED | EXAMINER AND GROUP ART UNIT |
|---|---|---|---|---|---|
| | 06/153,999 | 05/28/80 | 007 | 06/02/82 | DUGGAN, D 212 |
| First Named Applicant | STOLL, KURT | | | | |

TITLE OF INVENTION (This may have been amended by Exam): MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER

| BASE FEE COMPUTATION | | | BASE FEE DUE | ATTY'S DOCKET NO. | CLASS - SUBCLASS | BATCH NO |
|---|---|---|---|---|---|---|
| $100 + | 2 | (for dwg. @ $2 per sheet) + $10 = | 112 | M&R CASE 2A | 310-103.000 | KB5 |

The complete Issue Fee is one hundred dollars ($100) plus two dollars ($2) for each sheet of drawing, plus ten dollars ($10) for each printed page of specification (including claims) or portion thereof. Inasmuch as the final number of printed pages cannot be determined in advance of printing, an initial BASE ISSUE FEE (consisting of the fee for printing the first page of specification ($10) plus the fee of ($2) for each sheet of drawing, added to the fee of $100) MUST BE PAID WITHIN THREE MONTHS FROM THE DATE OF THIS NOTICE, or the application shall be regarded as ABANDONED. The Base Issue Fee will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

In order to minimize delays in the issuance of a patent based on this application, this Notice may have been mailed prior to completion of final processing by the Examining Group. It is recognized that the nature and/or extent of the remaining revision or processing requirements may cause slight delays in the printing of the patent. In addition, if prosecution is to be reopened, this Notice of Allowance will be vacated and the appropriate Office action will follow in due course. If the base issue fee has already been paid and prosecution is reopened, the applicant may request a refund or request that the fee be credited to a Deposit Account. However, applicant may wait until the application is either found allowable or held abandoned. If allowed, upon receipt of a new Notice of Allowance, applicant may request that the previously submitted base issue fee be applied. If abandoned, applicant may request refund or credit to a Deposit Account.

In the case of each patent issuing without an assignment, the complete post office address of the inventor(s) will be printed in the patent heading and in the Official Gazette. If the inventor's address is now different from the address which appears in the application, please fill in the information in the spaces provided on PTOL-85c enclosed. If there are address changes for more than two inventors, enter the additional addresses on the reverse side of the PTOL-85c.

The appropriate spaces in the ASSIGNMENT DATA section of PTOL-85b must be completed in all cases. If it is desired to have the patent issue to an assignee, an assignment must have been previously submitted to the Patent and Trademark Office or must be submitted herewith as required by 37 C.F.R. 1.334. Where there is an assignment, the assignee's name and address must be provided on the PTOL-85b to insure its inclusion in the printed patent.

Advance orders for 10 or more printed copies of the prospective patent can be made by completing the information in Section 4 of PTOL-85b and submitting payment therewith. If use of a Deposit Account is being authorized for payment, PTOL-85c should also be forwarded. The order must be for at least 10 copies and must accompany the issue fee. The copies ordered will be sent only to the address specified in section 1 or 1A of PTOL-85b.

If an additional fee is due, a Notice of Balance of Issue Fee Due will be mailed together with the patentee's copy of the patent. Payment must be made within three months from the date shown on said Notice since FAILURE TO PAY THIS BALANCE WITHIN THE SPECIFIED PERIOD WILL RESULT IN LAPSE OF THE PATENT.

☐ Note attached communication from Examiner.

☐ This notice is issued in view of applicant's communication filed _____

**IMPORTANT**

ATTENTION IS DIRECTED TO 37 C.F.R. 1.334

THE PATENT WILL ISSUE TO APPLICANT UNLESS AN ASSIGNEE IS SHOWN IN ITEM 3 ON FORM PTOL-85b, ATTACHED

**PATENT AND TRADEMARK OFFICE COPY**



**UNITED STATES DEPARTMENT OF COMMERCE**
**Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

| SERIAL NUMBER | FILING DATE | FIRST NAMED APPLICANT | ATTORNEY DOCKET NO. |
|---|---|---|---|
| | | | |

| EXAMINER | |
|---|---|
| | |
| ART UNIT | PAPER NUMBER |
| | |

DATE MAILED:

This is a communication from the examiner in charge of your application.

COMMISSIONER OF PATENTS AND TRADEMARKS

1. [X] THIS IS AN ATTACHMENT TO THE NOTICE OF ALLOWANCE AND BASE ISSUE FEE DUE, PTOL 85.
2. [ ] All the claims being allowable, PROSECUTION ON THE MERITS IS CLOSED in this application. If not attached hereto, a Notice of Allowance or other appropriate communication will be sent in due course.

   A. [ ] Note the attached PTO-152, Notice of Informality, which indicates that the declaration (or oath) is deficient and that a substitute is required. The substitute declaration (or oath) MUST BE SUBMITTED WITHIN THE THREE MONTH STATUTORY PERIOD SET FOR PAYMENT OF THE BASE ISSUE FEE IN THE "NOTICE OF ALLOWANCE AND BASE ISSUE FEE DUE" (PTOL-85), preferably with and attached to the base issue fee. Note that the statute does not permit extension of the three month period set for payment of the base issue fee. Failure to timely file the substitute declaration (or oath) will result in ABANDONMENT of the application. The transmittal letter accompanying the declaration (or oath) should indicate the following in the upper right hand corner:
   Issue Batch Number; Date of the Notice of Allowance, and Serial Number.

   B. [ ] Formal drawings are now required and MUST BE SUBMITTED WITHIN THE THREE MONTH STATUTORY PERIOD SET FOR PAYMENT OF THE BASE ISSUE FEE IN THE "NOTICE OF ALLOWANCE AND BASE ISSUE FEE DUE" (PTOL-85). Note that the statute does not permit extension of the three month period set to pay the base issue fee. Failure to timely submit the drawings will result in ABANDONMENT of the application. The drawings should be submitted as a separate paper with a transmittal letter which is addressed to the Official Draftsman and which indicates the following in the upper right hand corner:
   Issue Batch Number; Date of the Notice of Allowance, and Serial Number.

   C. [X] The claims are allowed in view of:
      a. [X] Applicant's communication filed 3/23/82.
      b. [ ] The interview summarized on the attached EXAMINER INTERVIEW SUMMARY RECORD, PTOL-413.
      c. [ ] The attached Examiner's Amendment. Should the changes and/or additions be unacceptable to applicant, an appropriate amendment may be proposed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted before, or with, payment of the Base Issue Fee.
      d. [ ] An Examiner's Amendment which will follow in due course.

   D. [ ] The allowed claims are _____

3. [ ] Note the attached Examiner's Statement of Reasons for Allowance. Any comments considered necessary by applicant regarding the reasons for allowance must be submitted no later than the payment of the Base Issue Fee, preferably with it, to avoid processing delays. Such submissions should be clearly labeled, "Comments on Statement of Reasons for Allowance".
4. [ ] Note attached NOTICE OF REFERENCES CITED, PTO-892, which is part of this communication. The listed references are considered to be pertinent to the claimed invention, but the claims are deemed to be patentable thereover.
5. [ ] Note attached LIST OF ART CITED BY APPLICANT, PTO-1449, which is part of this communication and serves as an acknowledgment of receipt of applicant's prior art statement. The references which were considered have been initialed on the form by the examiner, and the claims are deemed patentable thereover.
6. [ ] The drawings filed on _____ [ ] are acceptable as filed. [ ] are acceptable subject to correction as indicated on the attached Notice re Drawings, PTO-948. In order to avoid ABANDONMENT of this application, correction is required. Corrections can only be made in accordance with the instructions set forth in the attached letter "INFORMATION ON HOW TO EFFECT DRAWING CHANGES", PTO-1474.
7. [ ] The [ ] proposed drawing correction and/or the [ ] proposed additional or substitute sheet(s) of drawings filed on _____ has (have) been approved by the examiner. Applicant is reminded that in order to avoid abandonment of this applicant, execution of the proposed changes or submission of additional or substitute drawings MUST be made in accordance with the instructions set forth in the letter, "INFORMATION ON HOW TO EFFECT DRAWING CHANGES", PTO-1474, attached to Paper No. _____
8. [ ] The proposed drawing correction, filed _____, has been approved. However, the Patent and Trademark Office no longer makes drawing changes. It is now applicant's responsibility to ensure that the drawings are corrected. Corrections are required and MUST be effected in accordance with the instructions set forth on the attached letter "INFORMATION ON HOW TO EFFECT DRAWING CHANGES", PTO-1474.
9. [ ] In order to avoid ABANDONMENT, the drawing informalities noted on the Notice re Drawing, PTO-948, attached to Paper No. _____ must now be corrected. Applicant is reminded that the corrections can only be made in accordance with the instructions set forth in the letter "INFORMATION ON HOW TO EFFECT DRAWING CHANGES", PTO-1474, attached to the PTO-948.
10. [ ] Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has: [ ] been received. [ ] not been received.
    [ ] been filed in parent application, Serial No. _____ filed on _____

Donovan F. Duggan

DONOVAN F. DUGGAN
PRIMARY EXAMINER
ART UNIT 212

NOTICE OF ALLOWABILITY

PTOL-37 (REV. 3-82)



USCOMM-DC 82-P829

JUN 14 1982 PAT & TRADE

Applicant : Kurt Stoll

Serial No.: 153 999 Group 212

Filed : May 28, 1980 Examiner D. Duggan

For : MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER
Batch K85

Honorable Commissioner of Patents and Trademarks

Washington, D. C. 20231

CERTIFICATE OF MAILING

Sir:

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on

June 11, 1982.

BLANCHARD, FLYNN, THIEL, BOUTELL & TANIS, P.C.

Raywood H. Blanchard, Reg. No. 16 383
L. Martin Flynn, Reg. No. 17 835
Dale H. Thiel, Reg. No. 24 323
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Date: June 11, 1982

DGB/9
Correspondence: Amendment Under Rule 312 dated June 8, 1982
Claim of Priority



JUN 14 1982 PAT & TRADE

Applicant : Kurt Stoll June 8, 1982

Serial No.: 153 999 Group 212

Filed : May 28, 1980 Examiner D. Duggan

For : MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER
Batch K85

Honorable Commissioner of Patents and Trademarks

Washington, D. C. 20231

AMENDMENT UNDER RULE 312

Sir:

Pursuant to the provisions of Rule 312, Applicant respectfully requests entry of the following amendment:

Please change the title from "MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN AND A" to ---MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER---.

REMARKS

A routine review of this application prior to payment of the Issue Fee has revealed that the official Notice of Allowance as well as the Base Issue Fee Transmittal form for this application has an incorrect title printed thereon. The title was amended in an amendment dated November 2, 1981 and filed on or about November 4, 1981.

Applicant requests that a corrected Notice of Allowance and Base Issue Fee Transmittal form be issued in this particular matter. If the correction has not yet been made and notification issued prior to the current due date for payment of the Issue Fee, Applicant will utilize the Base Issue Fee Transmittal form and modify thereon in red ink the title so that it is in accord with the above set forth amendment.

Respectfully submitted,

By David G. Boutell
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MAIL DEPT. JUN 14 1982 TRADE MARK

RECEIVED JUN 16 1982 GROUP 210

Applicant : Kuft Stoll

Serial No.: 153 999

Filed : May 28, 1980

For : MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER

Group No. 212

Examiner D. Duggan

Date/Mailing Notice of Allowance: 6/2/82

Batch: K85

Honorable Commissioner of Patents and Trademarks

Washington, D. C. 20231

CLAIM OF PRIORITY

Sir:

Applicant(s) hereby claim(s) the right of priority based on German patent application Serial No. P 28 22 444.0 , filed June 1, 1979 . A certified copy of the application is enclosed in support of the claim of priority.

Respectfully submitted,

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Encl: Certified Copy of German Patent Application Serial No. P 28 22 444.0
Postal Card



JUN 14 1982

# BUNDESREPUBLIK DEUTSCHLAND

## Bescheinigung

Die Festo-Maschinenfabrik Gottlieb Stoll in 7300 Eßlingen hat eine Patentanmeldung unter der Bezeichnung

"Druckmittelbetätigter Linearmotor"

am 1. Juni 1979 beim Deutschen Patentamt eingereicht.

Die angehefteten Stücke sind eine richtige und genaue Wiedergabe der ursprünglichen Unterlagen dieser Patentanmeldung.

Die Anmeldung hat im Deutschen Patentamt vorläufig das Symbol B65G 51-04 der Internationalen Patentklassifikation erhalten.

München, den 8. Mai 1980
Der Präsident des Deutschen Patentamts
Im Auftrag

Schaal

Aktenzeichen:
P 29 22 444.0

28. Mai 1979
D 8007 - ossp

Festo-Maschinenfabrik Gottlieb Stoll
7300 Eßlingen / N

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Druckmittelbetätigter Linearmotor

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## Ansprüche

1. Druckmittelbetätigter Linearmotor für eine Transportvorrichtung, mit einem an eine Druckmittelquelle anschließbaren Rohr, mit einem im Rohr strömungsmitteldicht laufenden und eine hohlzylindrische innere Mitnehmer-Magnetanordnung tragenden Kolben und mit einem auf dem Rohr laufenden und eine hohlzylindrische äußere Mitnehmer-Magnetanordnung tragenden Abtriebsteil, bei dem die beiden Magnetanordnungen unter radialem Spiel zur benachbarten Rohroberfläche angeordnet sind, dadurch gekennzeichnet, daß die zum Rohr (10)





weisenden Oberflächen der inneren Magnetanordnung (20) und der äußeren Magnetanordnung (32) nur um eine kleine Strecke in radialer Richtung von den benachbarten Rohroberflächen entfernt sind und daß das Abtriebsteil (18) über an seinen Enden vorgesehene Abstreifringe (44) auf dem Rohr (10) läuit, während die an den Kolbenenden angeordneten Dichtringe (26) Abstreifringe für die innere Rohroberfläche darstellen.

2. Linearmotor nach Anspruch 1, dadurch gekennzeichnet, daß die Abstreifringe (44) des Abtriebsteils (18) in nach innen offenen Ringnuten (42) von radialen Stirnwänden (38) des Abtriebsteiles einsitzen.

3. Linearmotor nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Abstreifringe (44) des Abtriebsteils (18) und die Dichtringe (26) des Kolbens (16) in einer gemeinsamen, zur Achse des Rohres (10) transversalen Ebene liegen.

4. Linearmotor nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß der Kolben (16) in der Nachbarschaft der Dichtringe (26) Gleitführungsringe (24) trägt.

5. Linearmotor nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß das Rohr (10) aus einem dünnen rostfreien Material wie nichtmagnetise-hem Edelstahl, Messing oder Kunststoff besteht und als Druckmittel Wasser oder eine Mischung aus Wasser und Öl verwendet wird.

6. Linearmotor nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß das Rohr (10) aus einer Mehrzahl stumpf aneinander geschweißter Rohrsegmente (12a, 12b) besteht.

7. Linearmotor nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß die Abstreifringe (44) und die Dichtringe (26) aus elastisch nachgiebigem Material bestehen.

8. Linearmotor nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß das Abtriebsteil (18) eine die äußere hohlzylindrische Magnetanordnung (32) umgebende Hülse (30) aus magnetisierbarem Material aufweist.

9. Linearmotor nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß der Kolben (16) einen aus nicht magnetisierbarem Material bestehenden Kolbenkörper aufweist.

10. Linearmotor nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß die Magnetanordnungen (20, 32) jeweils durch axial aufeinanderfolgende, radial polarisierte Ringmagnete gebildet sind, welche durch dazwischenliegende, nicht magnetisierbare Distanzscheiben (22, 34) getrennt sind.

11. Linearmotor nach einem der Ansprüche 1 bis 10, dadurch gekennzeichnet, daß der Kolben an seinen Enden elastisch nachgiebige Puffer (28) trägt, deren Umfangsfläche ebenfalls unter radialem Abstand zur inneren Oberfläche des Rohres (10) verläuft.





12. Linearmotor nach Anspruch 11, dadurch gekennzeichnet, daß er eine Mehrzahl mit ihren Puffern (28) aneinander anstoßender Kolben (16) und eine entsprechende Mehrzahl, jeweils einem der Kolben zugeordneter Abtriebsteile (18) aufweist.

28. Mai 1979

D 8007 - ossp

Festo-Maschinenfabrik Gottlieb Stoll
7300 Eßlingen / N

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# Druckmittelbetätiger Linearmotor

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Die Erfindung betrifft einen druckmittelbetätigten Linearmotor für eine Transportvorrichtung gemäß dem Oberbegriff des Anspruchs 1.

Derartige Linearmotoren werden insbesondere für Transportvorrichtungen verwendet, und ihr Abtriebsteil ist dann mit einem Transportwagen für die zu fördernden Güter verbunden. Auf diese Weise können auch große Abmessungen aufweisende Güter rohrpostähnlich gefördert werden. Eine entsprechende Transportvorrichtung ist in der DE-OS 27 37 924 beschrieben.





Bei dem bekannten Linearmotor ist zur Sicherstellung eines störungsfreien Betriebes ein größeres radiales Spiel zwischen den einander gegenüberliegenden Oberflächen der Magnetanordnungen und des Rohres notwendig. Bisher war man der Auffassung, daß man nur auf diese Weise die stets vorhandenen Oberflächenrauhigkeiten und Querschnittsungenauigkeiten des Rohres aufnehmen kann. Andererseits wäre es natürlich im Hinblick auf die magnetische Mitnehmkraft zwischen Kolben und Abtriebsteil vorteilhaft, wenn man die Größe des Gesamtluftspaltes zwischen den beiden Magnetanordnungen klein halten könnte. Man könnte dann zur Erzielung einer gewünschten Mitnehmkraft zwischen Kolben und Abtriebsteil des Linearmotors kleinere und damit weniger schwere und insbesondere erheblich billigere Magnetanordnungen verwenden als bisher.

Durch die vorliegende Erfindung soll daher ein druckmittolbetätigter Linearmotor gemäß dem Oberbegriff des Anspruchs 1 so weiter gebildet werden, daß eine große Mitnehmkraft zwischen Kolben und Abtriebsteil erzielt wird und trotzdem kein Hängenbleiben von Kolben und Abtriebsteil am Rohr zu befürchten ist.

Diese Aufgabe ist erfindungsgemäß gelöst durch einen Linearmotor gemäß Anspruch 1.

Es wurde erkannt, daß die heutzutage zur Verfügung stehenden nicht magnetischen Rohrmaterialien eine so gute Oberflächenqualität aufweisen, daß an und für sich der Luftspalt

zwischen den Magnetanordnungen und den Rohroberflächen gegenüber dem Stand der Technik erheblich vermindert werden könnte, obwohl sich hieraus in der Praxis bisher immer nicht hinnehmbare Betriebsstörungen ergeben haben. Es wurde nun aber erkannt, daß diese Betriebsstörung nicht auf Oberflächenrauhigkeiten und Querschnittsungenauigkeiten des Rohrmateriales zurückzuführen sind (sogar Stumpfverschweißungen von Rohrabschnitten können heute mit sehr guter Oberflächengüte durchgeführt werden), sondern darauf, daß sich auf den Rohroberflächen stets Schmutz und Verunreinigungen befinden, welche bei klein gewählten Spalten zwischen den Magnetanordnungen und den Rohroberflächen nicht mehr durch diese hindurchlaufen können sondern in diesen verkeilt werden. Dies ist bei dem erfindungsgemäßen Linearmotor nicht mehr möglich, da die Abstreifringe des Abtriebsteiles bzw. die Dichtringe des Kolbens den unter die Magnetanordnungen einlaufenden Teil der Rohroberflächen sauber halten.

Vorteilhafte Weiterbildungen der Erfindung sind in Unteransprüchen angegeben.

Mit der Weiterbildung der Erfindung gemäß Anspruch 3 wird erreicht, daß durch den Anpreßdruck der inneren und äußeren Abstreifringe kein Verformen des Drehmoments auf das Rohr ausgeübt wird, welches vorzugsweise geringe Wandstärke haben soll, damit der Gesamtluftspalt zwischen den Magnetanordnungen klein gehalten werden kann.





Die Weiterbildung der Erfindung gemäß Anspruch 4 ist deshalb vorteilhaft, weil der Dichtring des Kolbens dann verhältnismäßig weich gewählt werden kann und zum großen Teil von Führungsaufgaben befreit werden kann. Hierdurch können die Reibungsverluste im Motor klein gehalten werden.

Bei einem Linearmotor gemäß Anspruch 5 erhält man eine sofort mit der Druckbeaufschlagung einsetzende und sofort mit der Beendigung der Druckbeaufschlagung zum Stillstand kommende Bewegung von Kolben und Abtriebsteil, was ein sehr genaues Positionieren des Abtriebsteils durch Schalten der Druckmittelversorgung ermöglicht. Außerdem braucht das Druckmittel keinen großen Druck aufzuweisen, da das Bewegen des Kolbens eher durch Mitnahme in einem Flüssigkeitsstrom als durch Differenzdruckbeaufschlagung erfolgt.

Gemäß Anspruch 6 läßt sich ein Linearmotor großer Länge realisieren.

Die Weiterbildung der Erfindung nach Anspruch 8 ist im Hinblick auf das Kleinhalten magnetischer Streufelder in der Umgebung des Abtriebsteiles von Vorteil. Auf diese Weise können unerwünschte Bremskräfte verhindert werden, welche sonst beim Vorbeilaufen von Kolben und Abtriebsteil an magnetisierbaren Maschinenteilen entstehen.

Bei einem Kolben gemäß Anspruch 9 kann das Gewicht besonders klein gehalten werden. Außerdem wird durch die Wahl nicht magnetisierbaren Materiales für den Kolbenkörper im durch das Abtriebsteil begrenzten Innenraum ein stärker inhomogenes Magnetfeld erhalten, was im Hinblick auf eine hohe Mitnahmekraft vorteilhaft ist.

Auch der segmentierte Aufbau der Magnetanordnungen, wie er im Anspruch 10 angegeben ist, trägt dazu bei, daß das Magnetfeld in axialer Richtung inhomogen ist, was wiederum das Mitnehmen des Abtriebsteiles durch den Kolben begünstigt.

Bildet man den Kolben gemäß Anspruch 11 aus, so kann er sehr präzise durch Anlaufen an einem starren Hindernis zum Halten gebracht werden. Ein weiterer Vorteil ist der, daß man auf diese Weise gemäß Anspruch 12 einen insgesamt große axiale Abmessung aufweisenden Kolben herstellen kann, der durch gekrümmte Rdrabschnitte bewegt werden kann, obwohl der radiale Abstand zwischen der inneren Magnetanordnung und der Rohrinnenwand nur klein ist. Man hat also einen langen Linearmotor mit gelenkig verbundenen Kolbenteilen und diesen zugeordneten, magnetisch gekoppelten, gegeneinander verschwenkbaren Abtriebsteilen. Ein derartiger Linearmotor kann somit eine große Traglast auf eine große Länge des Rohres verteilen, hat eine gute Mitnehmkraft zwischen Kolben und Abtriebsteil und kann trotzdem durch gekrümmte Rohrabschnitte bewegt werden.





Nachstehend wird die Erfindung anhand eines Ausführungsbeispieles unter Bezugnahme auf die beiliegende Zeichnung näher erläutert. In dieser zeigt die einzige Figur eine perspektivische Ansicht eines Linearmotors mit kleinem Luftspalt zwischen den Magnetanordnungen, wobei ein Abschnitt des Abtriebsteiles und des Rohres weggebrochen ist, um Einzelheiten des Kolbens zeigen zu können.

Die Zeichnung zeigt einen druckmittelbetätigten Linearmotor mit einem verhältnismäßig dünnen und verhältnismäßig kleinen Durchmesser aufweisenden Rohr 10 aus rostfreiem und nicht magnetischem Material, z. B. nicht magnetischem Edelstahl, Messing oder einem gegebenenfalls faserverstärktem Kunststoff. Dieses Rohr besteht aus stumpf zusammengeschweißten oder zusammengeklebten Rohrsegmenten 12a, 12b mit dazwischenliegenden Schweißnähten 14, welche sowohl auf der Rohrinnenseite als auch auf der Rohraußenseite keine Oberflächennnstetigkeiten bilden. Im Rohr 10, das wahlweise von seinen beiden Enden her mit einer Druckmittelquelle bzw. einer Druckmittelsenke verbindbar ist, ist ein insgesamt mit 16 bezeichneter Kolben angeordnet. Auf dem Rohr 10 läuft ein insgesamt mit 18 bezeichnetes Abtriebsteil des Linearmotors. Am letzteren ist eine nicht gezeigte Trageinrichtung für zu transportierende Güter befestigbar.

Der Kolben 16 hat einen aus Aluminium oder einem anderen nicht magnetischen Material mit geringem Gewicht gefertigten

Kolbenkörper. Dieser trägt axial aufeinanderfolgend Permanent-Ringmagnete 20, welche radial polarisiert sind und zwischen denen Distanzscheiben 22 angeordnet sind. Zu beiden Seiten der insgesamt hohlzylindrischen Anordnung von Ringmagneten 20 trägt der Kolbenkörper teilweise in Nuten des letzteren einsitzende und über die Kolbenkörperoberfläche überstehende und im Gleitsitz auf der Rohrinnenwand laufende Gleitführungsringe 24. Axial außerhalb der Gleitführungsringe 24 ist jeweils ein elastomerer Dichtring 26 vorgesehen, der ebenfalls in einer Nut des Kolbenkörpers einsitzt. Die beiden Stirnflächen des Kolbens tragen jeweils einen Puffer 28, über den der Kolben 16 an einem nicht wiedergegebenen feststehenden Anschlag abgebremst werden kann. Die Puffer 28 dienen ferner zur gelenkigen mechanischen Kopplung mehrere Kolben 16, wie weiter genauer beschrieben wird.

Die äußeren Mantelflächen der Ringmagnete 20 haben geringen Abstand zur Innenwand des Rohres 10. Da aber die Anordnung der Ringmagnete 20 zu beiden Seiten durch die Gleitführungsringe 24 und die Dichtringe 26 abgeschlossen ist, ist es nicht möglich, daß von der Herstellung des Rohres 10 in diesem verbliebene Verunreinigungen oder vom Druckmittel (vorzugsweise Öl oder eine Mischung aus 95 % Wasser und 5 % Öl) mitgeschleppte Verunreinigungen in den kleinen Spalt zwischen der Außenseite der Ringmagnetanordnung des Kolbens und die Innenseite des Rohres gelangt. Diese könnten zu einem Verklemmen des Kolbens 16 im Rohr 10 führen.





Vielmehr werden derartige Verunreinigungen von den Dichtringen 26 - und falls sie doch einmal an diesen vorbeikommen sollten noch von den Gleitführungsringen 24 - vor dem Kolben 16 hergeschoben, so daß der Ringmagnet-anordnung stets ein sauberer Abschnitt der Rohrinnenwand gegenüberliegt.

Das Abtriebsteil 18 des Linearmotors ist im wesentlich spiegelbildlich zum Kolben 16 aufgebaut, wobei die Spiegelfläche eine mitten zwischen den Rohroberflächen liegende Zylinderfläche ist. Dem Kolbenkörper entspricht so ein Hülsenteil 30, welches aber im Hinblick auf die Verminderung des magnetischen Streufeldes aus magnetisierbarem Material hergestellt ist. Das Hülsenteil 30 umgibt axial aufeinanderfolgende Permanent-Ringmagnete 32, die wiederum in radialer Richtung, und zwar in gleicher Richtung wie die Ringmagnete 12, polarisiert sind und durch dazwischenliegende Distanzscheiben 34 getrennt sind. Über elastomere Druckringe 36 sind die Ringmagnete 32 zwischen zwei ebenfalls aus magnetisierbarem Material gefertigte und mit dem Hülsenteil 30 verschraubte Stirnwände 38 eingespannt.

Die Stirnwände 38 haben eine das Rohr 10 unter geringem Spiel umgreifende mittige Öffnung 40, und in deren mit einem Material mit niederer Reibung, z. B. Tetrafluoräthylen beschichteter innerer Umfangswand ist eine nach innen offene Nut 42 vorgesehen, in welcher ein Abstreifring 44 läuft. Die Abstreifringe 44 sorgen beim Abtriebsteil 18, bei dem die innere Mantelfläche der hohlzylindrischen Magnetanordnung der

Ringmagnete 32 nur geringen Abstand von der Oberfläche des Rohres 10 aufweist, dafür, daß keine Fremdkörper in den kleinen Spalt zwischen den Ringmagneten 32 und der Rohroberfläche eintreten können. Derartige Fremdkörper, welche auf der der Umgebungsatmosphäre ausgesetzten Rohroberfläche stets angetroffen werden, werden also von den Abstreifringen 44 weggeschoben, bevor sie die Ringmagnete 32 erreichen.

Dadurch, daß man den gesamten "Luft-"Spalt zwischen der durch die Ringmagnete 20 gebildeten inneren Magnetanordnung und der durch die Ringmagnete 32 gebildeten äußeren Magnetanordnung (diese besteht aus dem Abstand der Ringmagnete 20 von der Rohrinnenwand, der Wandstärke des Rohres 10 und dem Abstand der Ringmagnete 32 von der Rohraußenwand) nun sehr klein wählen kann (kleine Fremdkörper brauchen nicht mehr zwischen den Magnetanordnungen und den Rohroberflächen hindurchtreten zu können), erhält man eine sehr gute magnetische Kopplung zwischen den beiden Ringmagnetanordnungen und damit eine gute Übertragung der vom Druckmittel bereitgestellten Kraft auf das Abtriebsteil.

Wie aus der Zeichnung ersichtlich ist, fluchten die Abstreifringe 44 und die Dichtringe 26 in radialer Richtung, so daß durch die Anpreßkraft auf das Rohr insgesamt kein Drehmoment ausgeübt wird. Durch diese Anordnung ist auch ein leichtes Bewegen von Kolben und Abtriebsteil über gebogene Rohrabschnitte hinweg möglich.





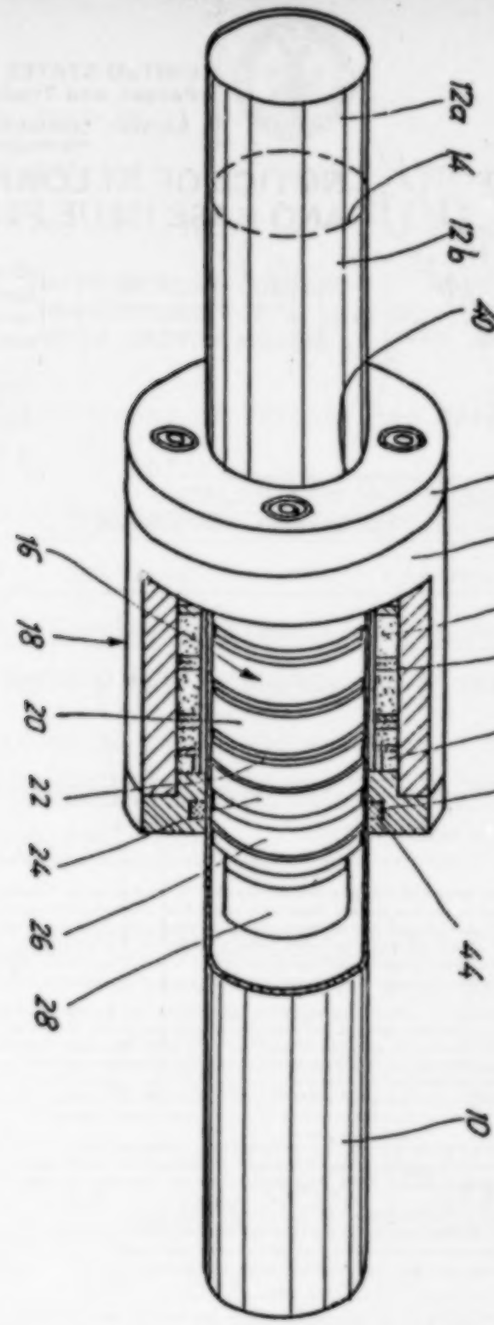
Der oben beschriebene Linearmotor kann leicht für das Befördern schwerer Lasten modifiziert werden. Man braucht hierzu nur in einem Rohrabschnitt mit Hilfsentlüftung zwei Kolben 16 hintereinander so anzuordnen, daß sie mit ihren Puffern 28 aneinander anstoßen, und für jeden Kolben ein Abtriebsteil auf das Rohr aufzuschieben, welches dann durch Magnetkräfte automatisch auf den zugehörigen Kolben ausgerichtet wird. Die Trageinrichtung für die Güter wird dann gelenkig mit jedem der Abtriebsteile verbunden. Die beiden Kolben bilden so effektiv einen Kolben doppelter (dreifacher usw.) Länge mit gelenkig "verbundenen"(durch Druck in Anlage aneinander gehaltenen) Einzelkolben, und die beiden (drei usw.) Abtriebsteile werden genau synchron bewegt. Auf diese Weise kann man das Gewicht der zu fördernden Last auf eine große Strecke des Rohres verteilen und erhält trotzdem keine Passungsprobleme, wie sie bei der Verwendung entsprechend langer Kolben und Abtriebsteile bei den erfindungsgemäß verwendeten kleinen Luftspalten zwischen den Magnetanordnungen und den Rohroberflächen erhalten würden. Auch gebogene Rohrabschnitte können durchfahren werden, was wiederum bei Verwendung entsprechend langer einstückiger Kolben und Abtriebsteile nicht möglich wäre.

Man erkennt, daß diese durch effektive Verlängerung des treibenden Teiles und des die Last tragenden Teiles Linearmotors ohne irgendwelche Veränderung an den Standardteilen (Kolben 16, Abtriebsteil 18) möglich ist, also auch am Einsatzort und nach der Erstinstallation noch ohne weiteres

möglich ist. Die Verteilung der Last auf eine größere Länge des Rohres 10 ist von besonderer Bedeutung bei der Verwendung von dünnen Rohren, welche im Hinblick auf die magnetische Kopplung zwischen Kolben und Abtriebsteil besonders vorteilhaft sind. Auch dünne Kunststoffrohre, welche im Hinblick auf die Oberflächenbeschaffenheit an sich sehr vorteilhaft sind, haben in der Regel keine sehr große Tragkraft, und für sie eignen sich somit derartige, gelenkig verbundene Kolben und Abtriebsteile aufweisende Anordnungen besonders gut.

Zum Anhalten des Abtriebsteiles bei einer gewünschten Stelle, wird dort ein auf die Druckmittelversorgung zum Rohr 10 arbeitender Stellungsgeber installiert, welcher entweder ein mechanisch oder optisch auf das Ankommen des Abtriebsteiles ansprechender Geber oder ein induktiver Geber oder ein auf magnetische Streufelder ansprechender Geber, z. B. ein Reed-Schalter sein kann.





**UNITED STATES DEPARTMENT OF COMMERCE**
**Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

Duplicate notice mailed 7/28/82

# NOTICE OF ALLOWANCE AND BASE ISSUE FEE DUE

BLANCHARD, FLYNN, THIEL
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All communications regarding this application should give the serial number, date of filing, name of applicant, and batch number.

Please direct all communications to the Attention of "OFFICE OF PUBLICATIONS" unless advised to the contrary.

The application identified below has been examined and found allowable for issuance of Letters Patent. PROSECUTION ON THE MERITS IS CLOSED.

| | SC/SERIAL NO. | FILING DATE | TOTAL CLAIMS | DATE MAILED | EXAMINER AND GROUP ART UNIT |
|---|---|---|---|---|---|
| | 06/153,999 | 05/28/80 | 007 | 06/02/82 | DUGGAN, D 212 |

First Named Applicant: STOLL, KURT

TITLE OF INVENTION (This may have been amended by Exam): MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN AND A

| BASE FEE COMPUTATION | | | BASE FEE DUE | ATTY'S DOCKET NO. | CLASS - SUBCLASS | BATCH NO |
|---|---|---|---|---|---|---|
| $100 + | 2 | (for dwg. @ $2 per sheet) + $10 = | 112 | MRR CASE 28 | 310-103.000 | KB5 |

The complete Issue Fee is one hundred dollars ($100) plus two dollars ($2) for each sheet of drawing, plus ten dollars ($10) for each printed page of specification (including claims) or portion thereof. Inasmuch as the final number of printed pages cannot be determined in advance of printing, an initial BASE ISSUE FEE (consisting of the fee for printing the first page of specification ($10) plus the fee of ($2) for each sheet of drawing, added to the fee of $100) MUST BE PAID WITHIN THREE MONTHS FROM THE DATE OF THIS NOTICE, or the application shall be regarded as ABANDONED. The Base Issue Fee will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

In order to minimize delays in the issuance of a patent based on this application, this Notice may have been mailed prior to completion of final processing by the Examining Group. It is recognized that the nature and/or extent of the remaining revision or processing requirements may cause slight delays in the printing of the patent. In addition, if prosecution is to be reopened, this Notice of Allowance will be vacated and the appropriate Office action will follow in due course. If the base issue fee has already been paid and prosecution is reopened, the applicant may request a refund or request that the fee be credited to a Deposit Account. However, applicant may wait until the application is either found allowable or held abandoned. If allowed, upon receipt of a new Notice of Allowance, applicant may request that the previously submitted base issue fee be applied. If abandoned, applicant may request refund or credit to a Deposit Account.

In the case of each patent issuing without an assignment, the complete post office address of the inventor(s) will be printed in the patent heading and in the Official Gazette. If the inventor's address is now different from the address which appears in the application, please fill in the information in the spaces provided on PTOL-85c enclosed. If there are address changes for more than two inventors, enter the additional addresses on the reverse side of the PTOL-85c.

The appropriate spaces in the ASSIGNMENT DATA section of PTOL-85b must be completed in all cases. If it is desired to have the patent issue to an assignee, an assignment must have been previously submitted to the Patent and Trademark Office or must be submitted herewith as required by 37 C.F.R. 1.334. Where there is an assignment, the assignee's name and address must be provided on the PTOL-85b to insure its inclusion in the printed patent.

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Applicant : Kurt Stoll

Serial No.: 153 999 — Group 212

Filed : May 28, 1980 — Examiner D. Duggan

For : MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER — Date of Mailing of Notice of Allowance: 6/2/82 Batch K85

Honorable Commissioner of Patents and Trademarks

Washington, D. C. 20231

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(Signature of party in interest of record) — (Date)
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|---|---|---|---|---|
| 06/153,999 | 05/28/80 | 007 | 06/02/82 | DUGGAN, D 212 |

First Named Applicant: STILL, KURT

TITLE OF INVENTION (this may have been changed by Exam): MAGNETICALLY COUPLED ARRANGEMENT FOR A DRIVING AND A DRIVEN MEMBER

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T. Hammond



Jan. 1, 1929. L. H. ROLLER 1,697,142

MATERIAL FOR MAGNETIC APPARATUS AND PROCESS OF MAKING SAME

Filed Nov. 21, 1925

Fig. 1.

Fig. 2.

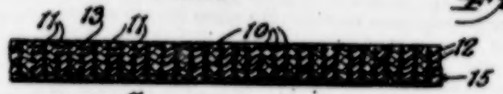


Fig. 3.

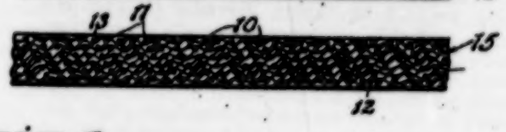


Fig. 4.

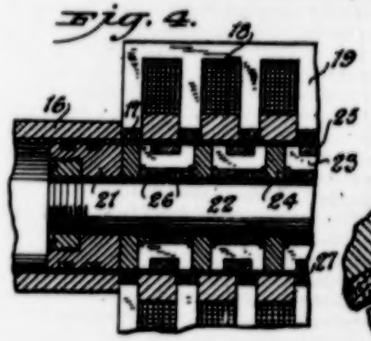


Fig. 6.

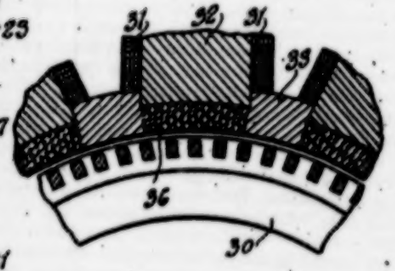


Fig. 5.

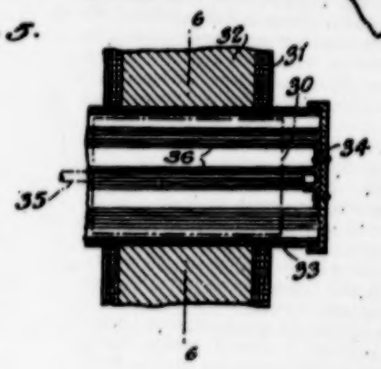


Fig. 7.

INVENTOR
L. H. Roller
BY
ATTORNEY

Patented Jan. 1, 1929.

1,697,142

# UNITED STATES PATENT OFFICE.

LOUIS H. ROLLER, OF WHITE PLAINS, NEW YORK.

## MATERIAL FOR MAGNETIC APPARATUS AND PROCESS OF MAKING SAME.

Application filed November 21, 1925. Serial No. 70,687.

My invention relates to an improved material adapted particularly for use in magnetic and electro-magnetic apparatus and to a process for making such material and it relates more particularly to a material which is mechanically strong, water proof, gas proof and in the main, a non-conductor of electricity and offering a high reluctance to the passage of magnetic lines of force, but having therein clearly defined paths of low magnetic reluctivity.

It is a well known practice to pass magnetic lines of force through the walls of a sealed container to perform work within the container instead of transmitting power by means of moving mechanical elements passing through the wall with the consequent danger of leakage around such elements. However, in order to avoid serious losses due to eddy currents, such walls must be made of electrically non-conducting material. On the other hand this has heretofore limited one to the use of materials that have a high magnetic reluctance; so that the walls have had to be very thin to avoid serious losses due to leakage of magnetic flux.

It is an object of the present invention to provide a material which overcomes these objections by providing a material which is not subject to appreciable eddy current losses, in which a low magnetic reluctance is provided where desired, and which, therefore, will provide a wall of considerable thickness without entailing material losses due to magnetic leakage.

A specific use of my improved material will be found in my co-pending application, Serial No. 710,680, filed May 2, 1924, which described an electro-magnetic pump in which magnetic lines of force were passed through a sealed cylinder into an armature to reciprocate the latter and in which the cylinder was made of non-metallic material containing zones of low reluctance formed by embedding soft iron particles in the material.

It will be obvious that there would be many other uses to which the material could be applied, in certain of which it would be desirable not to form the material in cylinders but to form it in other shapes. Furthermore, if formed in cylinders certain uses would require that the regions of low reluctance be arranged transversely to the axis of the cylinder while in other cases the regions of low reluctance should be arranged parallel to the axis of the cylinder.

In producing the material I employ a woven fabric of cloth in which fine threads of soft iron or other metal of high magnetic permeability are interwoven, the wire forming stripes in the cloth. The cloth is then impregnated with certain well known phenol condensation products and built up to any desired thickness by coiling it or piling it in layers with the stripes superposed. Thereafter the coil or pile is subjected to a heat and pressure to form a bakelite or condensite mass in which the wires are embedded.

I am aware that it is not new to embed metallic wires in bakelite or condensite, a patent on such material having been granted to John M. Taylor, December 12, 1922, No. 1,438,875. However, the material described in said patent was designed with an entirely different purpose in view, viz, that of strength so that the material could be used for gears and similar mechanical elements. Such material would be entirely unsuitable for my purpose, because the metallic strands are uniformly distributed throughout the material and must necessarily be so distributed for the purpose of giving uniform strength. But it will be evident that while such material would reduce the magnetic reluctivity such magnetic qualities would be uniformly distributed through the material and would defeat the purpose for which I intend to use my material. For the purpose I have in view it is essential that defined regions of low magnetic reluctance should be provided and that these regions be separated by regions of high reluctance otherwise there would be little advantage in using the material disclosed by Taylor cited, over that of using a continuous sheet or tube of iron. It is therefore, an object of my invention to provide a material in which the regions of low reluctance are separated by regions of high reluctance with no physical joint between such regions.

I also believe that I am the first to produce a fabric with separate stripes of iron wire woven therein. Heretofore, metallic wires have been interwoven with threads of textile material but the material contained wires running lengthwise as well as transversely to the material and was not confined to material in which the wires formed stripes running in one direction only.

A further object of my invention, therefore, is to provide a closely woven fabric having stripes of wire running in one direction only and to provide an efficient process for making such a fabric.

These and other objects I attain as hereinafter set forth, reference being had to the accompanying drawings in which

Figure 1 is a diagrammatic perspective view of a piece of fabric provided with threads of soft metal interwoven with non-metallic threads;

Fig. 2 is an edge view of a sheet of my improved material showing the iron wires arranged in layers vertically alined;

Fig. 3 is a view similar to Fig. 2 representing a modified form of my material in which the layers of iron wires are arranged in staggered relation to form inclined paths of low reluctance through the material;

Fig. 4 illustrates one application of my material showing in longitudinal cross section a fragmentary view of a magnetically operated pump having a cylinder of my improved material, the pump being similar in form to that disclosed in the aforesaid co-pending application;

Fig. 5 represents another application of my material illustrating a rotary motor of induction type in which the armature of the motor is enclosed in a casing formed of my improved material, the view representing a longitudinal section through a fragment of the casing with the armature of the motor indicated by broken lines;

Fig. 6 is a cross sectional view taken on the line 6—6 of Fig. 5: and

Fig. 7 is a diagrammatic plan view of another modification of my material illustrating how a plurality of spots of high magnetic permeability may be formed with angularly disposed layers of fabric.

Referring to Fig. 1, it will be observed that the fabric of which my material is composed has a warp of textile threads 10 displaced at intervals by metallic threads 11, while the weft threads 12 are all of textile material. As the object of this fabric is not to attain physical strength but magnetic permeability in defined regions the wires are preferably as fine as the textile threads. In practice it has been found inadvisable to use a large number of wire strands in the warp without interposing occasionally one or more textile threads between the wires. Because of the smoothness and hardness of the metallic strands the matting action which is desirable in weaving is absent, and there is a tendency for the filling threads to slide out between the warp threads while shedding. In other words, after the weft threads have been beaten into the shed by the reed, there is a tendency for the filling to slide out during the shedding operation, that is, during the raising and lowering of alternate warp strands. This is prevented, however, by introducing a thread of textile material between the wire warp threads. In practice it is found that desirable matting can be obtained if one or more threads of textile material be introduced between every four or five metallic threads. I therefore, form the warp with stripes of metallic wires interspersed with textile threads as shown at 13 in Fig. 1. It will be understood of course, that the stripe of iron wire need not be confined to the number shown in the drawing but may extend over any desired width of the fabric provided warp threads of textile material are introduced at sufficiently frequent intervals to produce the desired matting of the fabric. Having produced the fabric shown in Fig. 1 the next step of my process is to impregnate the fabric with a phenolic condensation product, after which layers of fabric are arranged in a pile as shown in Fig. 2 with the stripes of metallic wire in superposed alined relation. The fabric may be arranged in a flat pile or may be wound in a coil to form a solid rod or it may be wound around a form, if it be desired, to produce a cylindrical, rectangular or other form. The pile of fabric is then subjected to pressure and heat and the condensation product fills the spaces between the textile threads and between the wires inseparably binding all parts together in a uniform hard substance in which wire is thoroughly embedded. The material is very strong and shows no tendency to cleavage between regions of high reluctance and low reluctance. The material is also water proof and gas proof and a good electrical insulator except where the wire provides a path for electric current and, because the wire strands are separated by the textile threads and the impregnating condensite product, a high resistance to electric current is offered, which tends in use to prevent the formation of eddy currents. At the same time the magnetic reluctance of the material is markedly lowered in the zones or regions traversed by the wires.

As explained above one of the principal uses for which this material is adapted is to be found in the art of refrigeration in which it is desirable to have a closed system sealed against gas leakage and in which mechanical work may be performed by means of energy transmitted from without the system, avoiding any moving member passing into the system. Such an application was described in the aforesaid co-pending application and is illustrated in Fig. 4. It comprises a pump employing a cylinder 16 formed of my improved material, having therein zones 17 of low magnetic reluctance running circumferentially about the cylinder. The cylinder is surrounded by field coils 18 located in comb-shaped yokes 19, the teeth of which engage the zones 17. Within the cylinder 16 is a pump plunger 21 carried by a

rod 22 on which are mounted a plurality of armature sections 23 separated by collars 24, each armature section consisting of soft iron segments held in place by retaining rings 25 and tightly secured by means of wedges 26. Although condensite and bakelite are generally considered to be insoluble, I have found that they are not insoluble in anhydrous ammonia and hence, it is desirable to line the cylinder with some material, such for instance, as tin, which is not affected by ammonia when my pump is to be used for pumping ammonia gas. Such a liner is indicated at 27 and as it is not required to have any great strength, because the cylinder itself is strong enough to resist any pressures developed by the pump, it may be made merely thick enough to prevent actual contact of any liquid ammonia with the bakelite or condensite surface. The liner may be applied to the cylinder electrolytically or in any other suitable manner and as its purpose is merely to provide a coating non-soluble in the fluids handled by the pump it need not necessarily be of metal. But if a metal liner be used it should be non-magnetic so as not to divert the lines of magnetic flux passing between the yoke 19 and the armatures 23 through the zones 17. Because the material of which the cylinder is composed offers considerable reluctance to the passage of magnetic lines of force, an easier path for the flux is found through the zones 17 into and out of the armatures 23, and because of the thinness of the liner 27 there is no appreciable loss due to leakage of flux. It will be understood of course, that when the pump is to be used for pumping other gases or liquids which do not affect my improved material the liner 27 may be dispensed with.

While I have illustrated my improved material as employed with a reciprocating pump, it will be evident that it can also be used with any solenoid or any straight line motor. Fig. 5 illustrates another application in which the material is employed in connection with a rotary motor. The figure shows a cross sectional view of an induction motor with the armature removed but indicated by broken lines at 30. The field windings 31 and core 32 are separated from the armature by a casing 33 of my improved material in which bearings (one being indicated at 34) are provided for the armature shaft 35. A construction such as this can be used in refrigerating apparatus to provide rotary motion within a sealed casing transferring energy through the walls of the casing without any mechanical transmission of motion through the casing. In this application of my material, however, the regions of low magnetic reluctance must not run circumferentially about the casing but must run parallel to the axis of the armature, otherwise there would be a magnetic short circuit between the field poles and little or no magnetic flux would reach the armature. Instead the lines of low magnetic reluctance run lengthwise of the cylindrical casing 33 as indicated at 36. In building up a casing of this sort, it will be evident that care must be exercised to arrange the layers of fabric so that the wire stripes of the outer layers will be wider than those of the inner layers, thus forming the sector shaped regions illustrated in the cross sectional view of Fig. 6. In forming the fabric it will be necessary to compute the number of wires required to effect this result. In other words, the stripes of metal must be progressively wider across the width of the fabric and must be separated by successively wider stripes of non-metallic fabric as we proceed from the inner to the outer layers. It is possible to arrange the warp of the fabric with considerable accuracy so that the successive layers will fall one above the other as the fabric is wound widthwise about a form. However, while it is desirable that the zones of low magnetic reluctance be defined transversely by radial lines, this result is not essential to the successful use of my material. For instance, there could be and in commercial practice doubtless would be, considerable irregularity along the margins of the zones, provided the principal object is maintained of producing a path of much lower reluctance through the material into the armature than exists between successive fields of poles, so that by far a greater part of the magnetic energy will pass into the armature instead of leaking across from one pole to another. It will be noted that the thickness of the casing is much greater between poles of the armature in Fig. 6 as well as between the legs of the yokes 19 of Fig. 4. My object is to provide sufficient strength by using a casing of fairly heavy thickness but this material is machined down or otherwise reduced along the zones or regions where the wire is embedded so as to reduce the thickness at these points as much as possible and thereby reduce the magnetic reluctance. At these points not only is the material reinforced by the wire therein, but it is also reinforced by the pole pieces which bear against the wire zones, so that the cylinder is not materially weakened by such reduction of thickness.

I have described the fabric of which my material is composed as having wire stripes running lengthwise or in the warp of the material. In commercial practice it is simpler to weave a frabric with wire strands in the warp rather than in the wefts, but it would be possible and in certain cases preferable to use wire in the weft rather than in the warp and hence I do not limit myself to a fabric with wire warp strands.

I have referred to the fact that it is not essential that the wire stripes of one layer be accurately superposed upon the wire stripes





of the next adjacent layer in building up my material. Indeed in some cases I find it desirable to offset the successive layers somewhat, so as to obtain the result shown in Fig. 3 wherein the paths of low reluctance through the material, are inclined instead of being normal to the plane of the material.

Another modification is illustrated diagrammatically in Fig. 7 which shows the wire stripes of a plurality of layers of fabric, the body of the fabric being omitted. Three layers of stripes $11'$, $11^2$ and $11^3$ are indicated, each layer forming an angle of 60 degrees with the other two. When the material is made up of layers so disposed there will be intersecting spots where the magnetic reluctance is but one third of that through other parts of the material traversed by the stripes. The material may be built up of any number of layers thus angularly disposed and smaller angular displacements may be used to further reduce the relative reluctivity at isolated spots. In fact the layers may each be provided with a single stripe or even a single wire and the successive layers be assembled with a minute angular displacement about a common intersecting point, when the transverse path of low reluctivity at such point will have a relative reluctance value inversely proportional to the number of the angles of displacement.

I claim:

1. A material for use in magnetic apparatus consisting of a solidified plastic substance having layers of textile fabric embedded therein, the fabric being formed with interwoven stripes of soft iron wire.

2. A material for use in magnetic apparatus consisting of a series of fabric layers bound together by a solidified phenolic condensation product, each layer including a stripe of magnetizable strands woven into the fabric.

3. A material for use in magnetic apparatus consisting of a series of fabric layers bound together by a solidified phenolic condensation product, each layer including a stripe of highly para-magnetic metal woven into the fabric.

4. A material for use in magnetic apparatus consisting of a series of fabric layers bound together by a solidified phenolic condensation product, each layer including a stripe of soft iron wire woven into the fabric.

5. A material for use in magnetic apparatus consisting of a series of fabric layers bound together by a solidified phenolic condensation product, each layer including a stripe of low reluctance wire woven into the fabric, the stripes being superposed and alined.

6. A material for use in magnetic apparatus consisting of a series of fabric layers bound together with a solidified phenolic condensation product, and each layer including a stripe of low reluctance wire woven into the fabric, the stripe of each layer being disposed in a pre-determined geometric relation to the stripes of adjacent layers.

7. A material for use in magnetic apparatus consisting of a series of fabric layers bound together by a solidified phenolic condensation product and each layer including a stripe of iron wire woven into the fabric, said stripes being disposed in superposed relation, and a protective coating on the surface of the material.

8. A material for use in magnetic apparatus consisting of a series of fabric layers bound together by a solidified phenolic condensation product and each layer including a stripe of iron wire woven into the fabric, said stripes being disposed in superposed relation, and a non-magnetic metallic coating on the surface of the material.

9. A cylinder for use in a magnetic apparatus consisting of a length of fabric having a stripe of iron wire woven therein, the fabric being spirally wound to form a coil and the whole being bound together by a solidified phenolic condensation product.

10. A cylinder for use in magnetic apparatus consisting of a hollow cylindrical coil of fabric bound by a solidified phenolic condensation product, the fabric including a circumferentially disposed stripe of iron woven into the fabric.

11. A cylinder for use in a magnetic apparatus consisting of a length of fabric having a stripe of iron wire woven therein, the fabric being spirally wound to form a hollow cylindrical coil and the whole being bound together by a solidified phenolic condensation product, and a protective coating on the inner surface of the cylinder.

12. The process of making material for magnetic apparatus which consists in weaving a fabric of textile material with stripes of metal threads interwoven therein, impregnating the fabric with a phenolic condensation product, arranging the fabric in layers with the stripes in superposed and alined relation, and subjecting the whole to heat and pressure.

13. The process of making material for magnetic apparatus which consists in impregnating textile fabric with a phenolic condensation product, the fabric having stripes of metal interwoven therein, arranging the fabric in layers with the stripes of each layer disposed in a pre-determined geometric relation to the stripes of adjacent layers, and subjecting the whole to heat and pressure to solidify the phenolic condensation product.

14. The process of making material for magnetic apparatus which consists in impregnating textile fabric having stripes of metal interwoven therein, with a phenolic condensation product, arranging the fabric in layers with the stripes of the several layers disposed to superposed and alined rela-

tion, and subjecting the whole to heat and pressure.

15. The process of making material for magnetic apparatus which consists in impregnating with a phenolic condensation product a textile fabric having stripes of metal interwoven therein, winding the fabric about a form with the stripes of metal in the several coils of the winding disposed in superposed and alined relation, and subjecting the whole to heat and pressure.

16. A material for use in magnetic apparatus consisting of a solidified plastic substance having layers of textile fabric embedded therein, the fabric being formed with interwoven stripes of magnetizable material.

LOUIS H. ROLLER.



Aug. 4, 1959 A. RICHTER ET AL 2,898,485

MAGNETIC CLUTCH

Filed Sept. 17, 1957

Fig. 1.

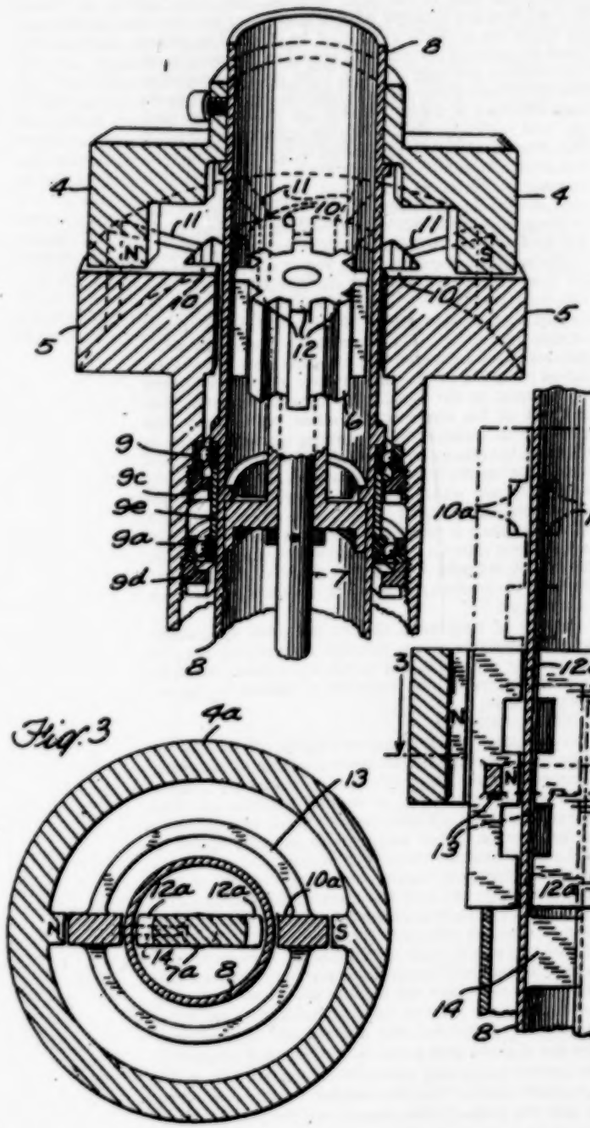


Fig. 2.

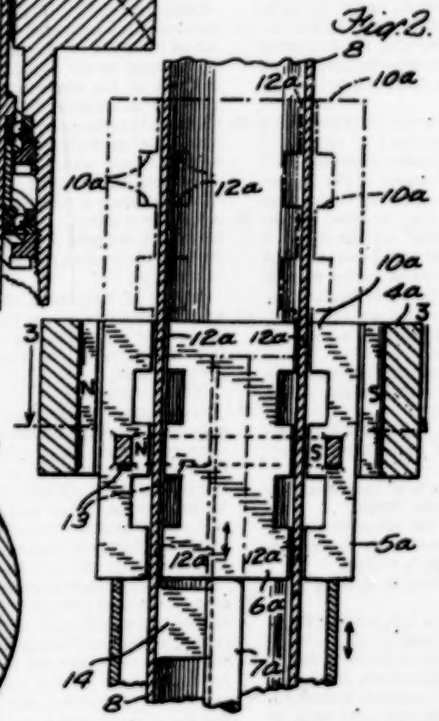


Fig. 3

United States Patent Office

2,898,485

Patented Aug. 4, 1959



2,898,485

# MAGNETIC CLUTCH

Albert Richter, Lynbrook, and Vincent Ordorica, Brooklyn, N.Y., and Donald Gertz, Oak Ridge, Tenn., assignors to Sperry Rand Corporation, Ford Instrument Company Division, Long Island City, N.Y., a corporation of Delaware

Application September 17, 1957, Serial No. 684,490

9 Claims. (Cl. 310—104)

This invention relates to a magnetic clutch and particularly to a system for transmitting motion from one member to another member in a magnetic flux field.

Heretofore motion transmitting systems have depended on the employment of linear or rotating synchronous motors wherein the motion is transmitted from a stator to the controlled rotor element by the magnetic field as a function of supply frequency. In most control applications, the required speeds of motion are too slow to permit control with motors of conventional design operating from normally available supply frequencies. Various expedients have been adopted to overcome the limitations of the synchronous motor control such as the provision of speed reducing gear trains and low frequency power suppliers.

According to this invention, a motor of conventional design may be employed to impart linear or rotary motion to a member fabricated of magnetic material which transmits the motion to a second member of like character by means of magnetic field produced by a stationary magnetic member. Brushes, slip rings or other components subject to wear are not required and the system is adapted to be driven by conventional power sources. The system is particularly adapted to transmit motion through a metallic non-magnetic wall interposed as between the two members although other applications are anticipated.

One object of the invention is to provide a magnetic clutch of single and durable design.

Another object is to provide a magnetic clutch operative in a field produced by a stationary magnet which is thus independent of the supply frequency.

Another object of the invention is to provide an improved magnetic clutch capable of transmitting and responding to rotary motion.

A further object of the invention is to provide an improved linear motion type of magnetic clutch.

Other objects and advantages of the invention may be appreciated from the following specification in conjunction with the accompanying drawings, in which

Fig. 1 is a perspective in partial section showing a rotary type magnetic clutch.

Fig. 2 is a vertical section taken on line 2—2 of Fig. 3 showing linear motion type of magnetic clutch; and

Fig. 3 is a section in plan of the clutch shown in Fig. 2.

As shown in Fig. 1, the magnetic clutch includes a stationary magnet 4, an outer rotary member 5 rotatable in flux linking adjacency to the north and south poles of the stationary magnet and an inner rotary member 6 mounted on a shaft 7 and concentrically disposed within the outer member. A non-magnetic wall 8 is interposed between the members. The stationary magnet is bolted to the wall 8 and may be of the permanent (as shown) or electro-magnetic type. Bearings 9 and 9*a* are supported between the member 5 and the wall 8 by means of rings 9*c* and 9*d* threadably secured to the member 5 and a brace 9*e* fitted about the wall between the bearings.

The rotary members are made of a magnetic material of minimal magnetic retention such as soft iron. The



outer rotary member 5 has circumferentially mounted on its inner face a series of inwardly projecting elements 10 which are established by the field as salient poles. The poles are magnetically insulated by non-magnetic sections 11 which are interposed between the poles so as to preclude a flux path in the outer member. The inner rotary member 6 is provided with corresponding pole pieces 12 which are similarly established by the field as salient poles of opposing polarity with respect to the corresponding poles on the outer member. The polarized members thereby present a flux path of minimum reluctance to the magnetic lines of force. Because the lines of force seek the least reluctance path across the poles of the magnet, they tend to align the salient poles of the inner and outer members. It is apparent, therefore, that if the outer member is rotated at the desired speed as by a motor (not shown) an alignment torque, which is proportional to the square of the flux density, will be produced which will tend to rotate the inner member in synchronism.

The magnetic clutch shown in Figs. 2 and 3 is arranged for linear motion transmission and response. The outer and inner members 5*a* and 6*a*, respectively, are concentrically disposed between the poles of an uninsulated, stationary magnet 4*a*. The salient poles 10*a* of the outer member 5 are supported by connecting rings 13 and the salient poles 12*a* of the inner member are axially aligned with respect to the direction of imparted motion. The tendency of the corresponding salient poles of the two members to maintain their opposing positions so as to minimize the reluctance presented to the magnetic lines of force between the poles of the magnet is present in this form of clutch whose structure is slightly modified for linear motion operation. The outer member may be caused to move in linear translation as by a lead screw or rack (not shown). An inwardly projecting key 14 on the wall 8 engaging a keyway in the shaft of the inner member 6*a* precludes rotation of the inner member on its actuation.

It must be understood that various other applications and embodiments of the principle of invention may be effected by persons skilled in the art without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A motion transmitting mechanism comprising an elongated non-magnetic tubular wall defining a container, a control element mounted in said container for longitudinal movement therein, a magnet mounted in fixed spaced relation to said container concentric with the outer surface thereof, a first magnetizable element secured to said control element within said container for movement in unison therewith, means preventing rotation of said control element and said first magnetizable element during longitudinal movement thereof, a second magnetizable element disposed between said magnet and the outer surface of said tubular wall for longitudinal movement with respect thereto, said magnet being provided with diametrically opposed positive and negative pole pieces projecting radially inwardly from an annulus, said first magnetizable element being provided with diametrically opposed positive and negative pole pieces, and said second magnetizable element comprising diametrically opposed pole pieces connected together by a ring member, the said pole pieces of said first magnetizable element and the pole pieces of said second magnetizable element being adapted to be magnetized by said magnet and when magnetized to radially align whereby longitudinal movement of one of said magnetizable elements will be imparted to the other of said magnetizable elements.

2. A motion transmitting mechanism as defined in claim 1 in which said magnet comprises a permanent







magnet having a single pair of diametrically opposed positive and negative pole pieces.

3. A motion transmitting mechanism comprising an elongated non-magnetic tubular wall defining a container, a control element mounted in said container for longitudinal movement therein, a magnet mounted in fixed position with respect to said container, a first magnetizable element secured to said control element within said container for movement in unison therewith, a second magnetizable element disposed outwardly of said container for longitudinal movement with respect thereto; said magnet, said first magnetizable element and said second magnetizable element being each provided with positive and negative pole pieces; the said pole pieces of said first magnetizable element and the said pole pieces of said second magnetizable element being adapted to be magnetized by said magnet and when magnetized to radially align whereby longitudinal movement of one of said magnetizable elements will be imparted to the other of said magnetizable elements.

4. A motion transmitting mechanism as defined by claim 3 in which said magnet comprises a permanent magnet having a single pair of diametrically opposed positive and negative pole pieces.

5. A motion transmitting mechanism as defined by claim 4 in which said first magnetizable element comprises a single pair of diametrically opposed positive and negative pole pieces.



6. A motion transmitting mechanism as defined by claim 5 in which said second magnetizable element comprises a single pair of diametrically opposed positive and negative pole pieces.

7. A motion transmitting mechanism as defined by claim 3 in which said first magnetizable element comprises a single pair of diametrically opposed positive and negative pole pieces.

8. A motion transmitting mechanism as defined by claim 7 in which said second magnetizable element comprises a single pair of diametrically opposed positive and negative pole pieces.

9. A motion transmitting mechanism as defined by claim 3 in which said second magnetizable element comprises a single pair of diametrically opposed positive and negative pole pieces.

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# United States Patent [19]

**Isbell**

[11] **3,847,502**

[45] **Nov. 12, 1974**


[54] **CONVEYING AND FORCE PRODUCING MEANS**


[76] Inventor: **Joe A. Isbell**, 5299 Mesquite Rd., Memphis, Tenn. 38117



[22] Filed: **Dec. 2, 1972**

[21] Appl. No.: **317,078**

**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 185,533, Oct. 1, 1971, abandoned.

[52] **U.S. Cl.** ..... **415/92**, 415/202, 417/410, 310/104

[51] **Int. Cl.** ..... **F01d 1/00**

[58] **Field of Search** ..... 104/156; 418/158; 415/92, 415/202, 152; 310/104



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*Primary Examiner*—C. J. Husar
*Attorney, Agent, or Firm*—John R. Walker, III



[57] **ABSTRACT**

A means for conveying an object or producing a force. The conveying and force producing means includes a movable metal slug slidably mounted in a tube. There is provided a fluid system to cause movement of the slug in the tube. A magnet on the outside of the tube is coupled by electromagnetic force to the slug and follows the movements of the slug to produce a force and perform work, such as moving an object. An alternate embodiment is provided in which the magnet is on the inside of the tube and the metal slug is on the exterior of the tube. A third embodiment is provided in which the tube is endless, i.e., having the shape of a ring, and a plurality of spaced apart slugs are forced to travel within the endless tube, i.e., by the fluid system. A plurality of outer members is included, i.e., one for each slug which are interconnected to a concentric common shaft. The outer members or the slugs are magnetized to cause the outer member to follow the spinning slugs, thus rotational force is imparted to the shaft.


**17 Claims, 16 Drawing Figures**

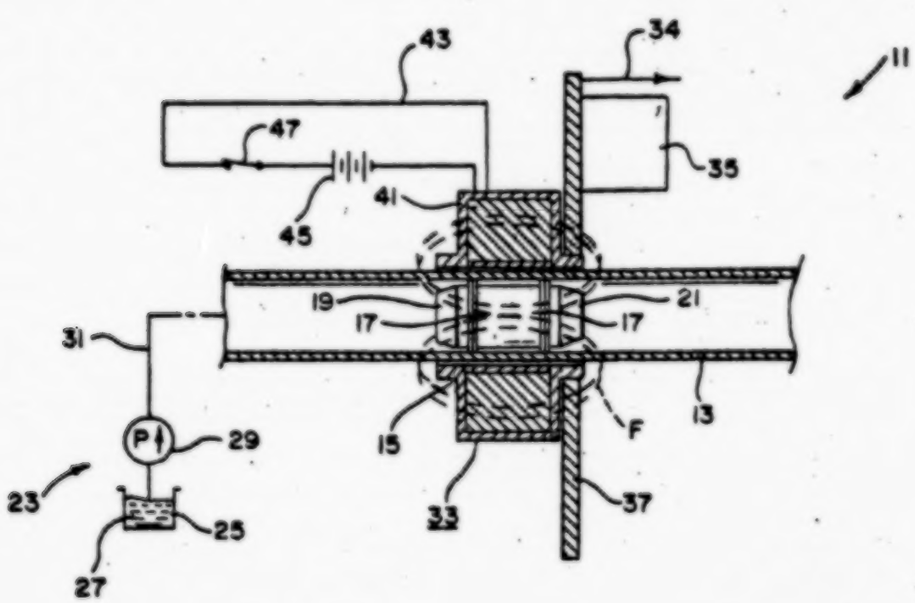







FIG. 1

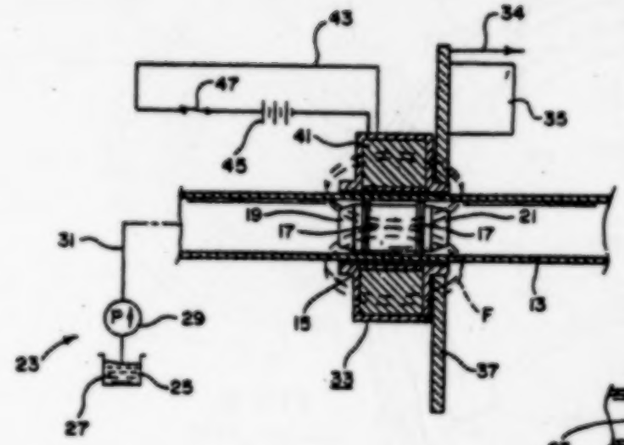



FIG. 3

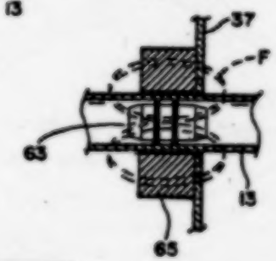



FIG. 2

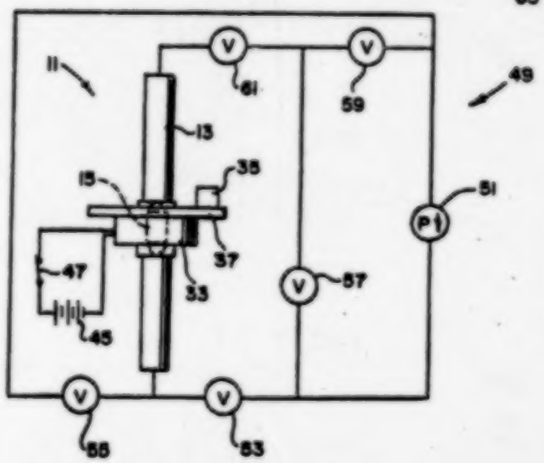


FIG. 4

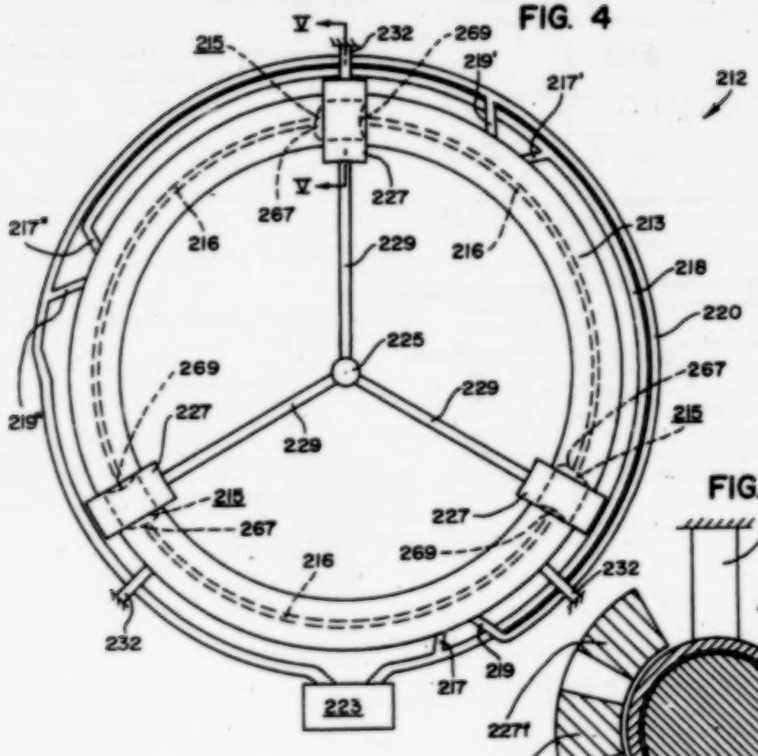



FIG. 5

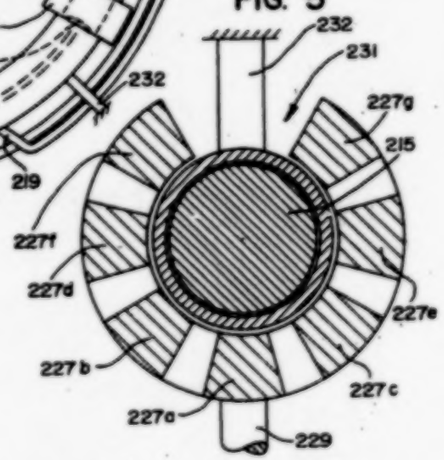



FIG. 6

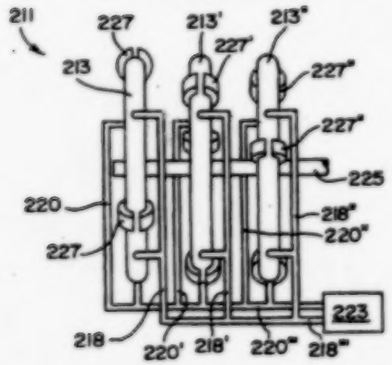



FIG. 7

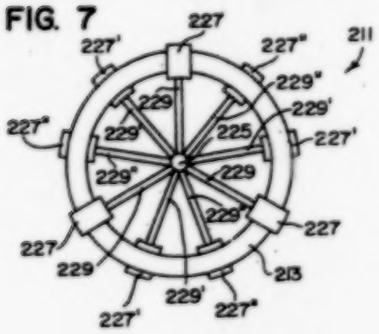







FIG. 8

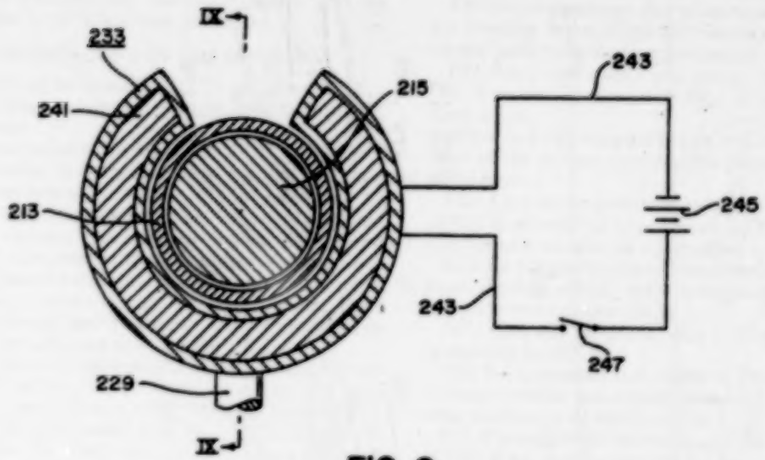



FIG. 9

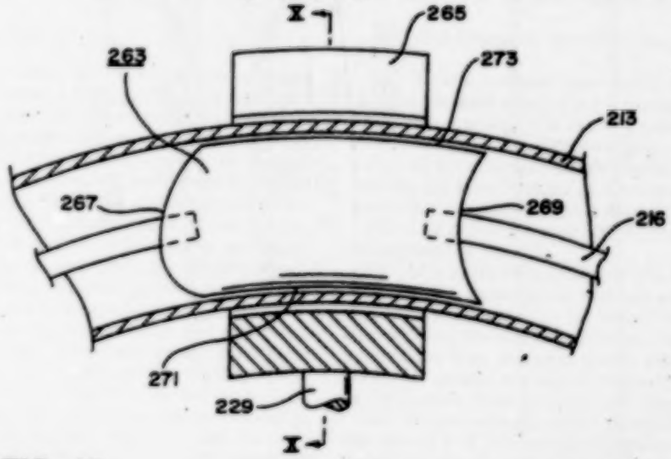



FIG. 10

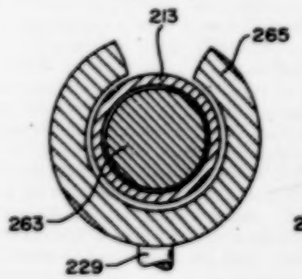



FIG. 11

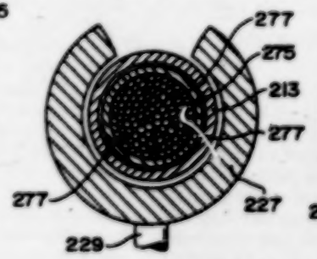
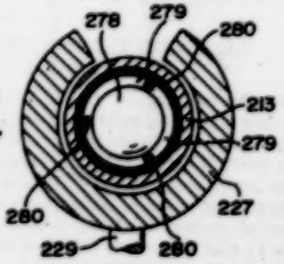



FIG. 12



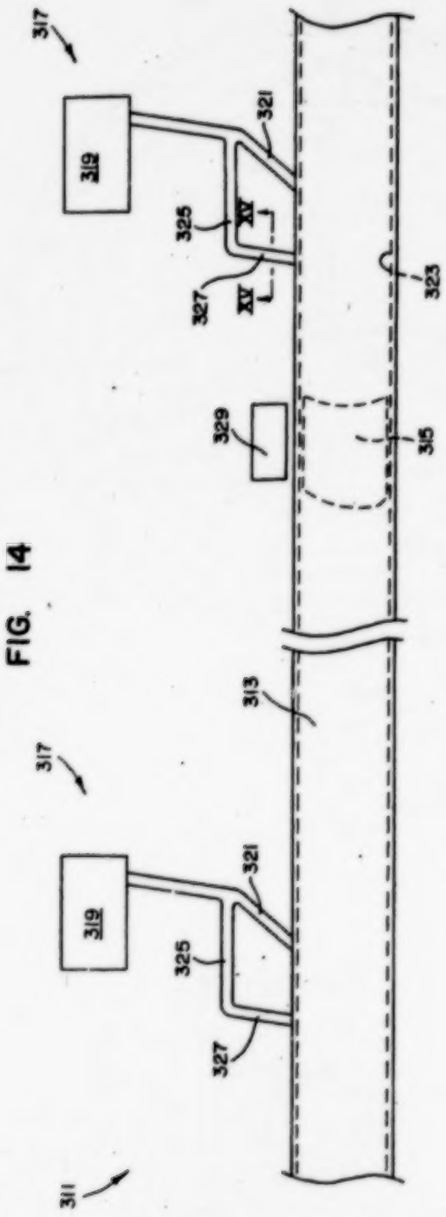



FIG. 14

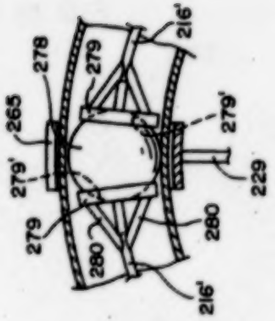



FIG. 13

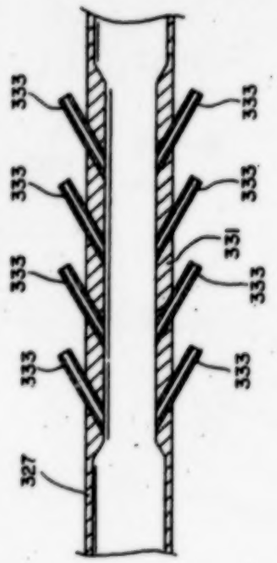



FIG. 16

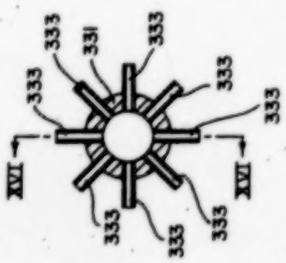



FIG. 15





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# CONVEYING AND FORCE PRODUCING MEANS

## CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my copending application entitled *CONVEYING AND FORCE PRODUCING MEANS*, Ser. No. 185,533. filed Oct. 1, 1971, and now abandoned.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to conveying and force producing means.

2. Description of the Prior Art

Heretofore, in fields such as the elevator field, there have been hydraulic elevators in which either air or hydraulic fluid drives a piston which is directly connected to the elevator cab to cause raising and lowering thereof. Also, another type of commonly known elevator has been the electric motor driven elevator in which the electric motor, through pulleys and cables, which support the cab and are attached thereto, moves the elevator upwardly and downwardly.

A preliminary patentability search revealed the following U.S. Pat. Nos.: 573,820, issued Dec. 22, 1896; 613,627, issued Nov. 1, 1898; 827,282, issued July 31, 1906; 1,231,075 issued June 26, 1917; 2,222,685, issued Nov. 26, 1940; and 2,927,661, issued Mar. 8, 1960. None of the above patents show or suggest applicant's device.

## SUMMARY OF THE INVENTION

The present invention is directed towards providing a means for producing a force and perform work such as conveying an object. It is an object of the present invention to provide such a conveying or force producing means in which a driving member or slug is not coupled directly to the driven structure, but instead is coupled electro-magnetically. Thus, one of the concepts of the present invention is to provide a tube, a metallic slug slidably mounted in the tube, a fluid system for supplying fluid to the tube to move the slug, a movable object, and a magnet slidably mounted on the exterior of the tube adjacent the slug for magnetically coupling the object to the slug for moving the object to follow the movements of the slug. Also, it is a concept of the present invention that the magnet and the slug may be reversed, that is, the magnet may be disposed on the interior of the tube and the slug on the outside. To clarify, the magnet and the slug coact together to create a magnetic means for magnetically coupling the magnet to the slug to cause the magnet to move along with the slug. It should be apparent that the slug includes a magnetic substance capable of being magnetized or attracted by a magnet. Further, the tube may be endless, i.e., being in the form of a ring, with a plurality of spaced apart slugs which are forced to travel or spin within the tubular ring by the fluid system. This latter concept also includes a plurality of outer members, i.e., one for each slug, which are interconnected to a shaft that is concentrically disposed within the tubular ring. Either the outer members or the slugs are magnets to magnetically couple them together. This causes the outer members to follow the spinning slugs, thus rotational force is imparted to the shaft. Other objects of the present invention will be more apparent from the following description and claims.

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## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross sectional view of the means of the present invention shown as arranged for horizontal conveying or for producing a horizontal force, and with certain parts being shown schematically.

FIG. 2 is an elevational view of the means of the present invention shown as applied to an elevator and with certain parts being shown schematically.

FIG. 3 is a view similar to a portion of the view of FIG. 1 showing an alternative form of the present invention. i.e.,

FIG. 4 is a side elevational view of a third embodiment of the present invention for producing a rotational force.

FIG. 5 is a sectional view taken as on the line V—V of FIG. 4, showing the inner member as a metallic slug and the outer member as a permanent magnet.

FIG. 6 is a front elevational view of the third embodiment showing several units as depicted in FIG. 4 ganged to one common shaft.

FIG. 7 is a side elevational view of the ganged units as depicted in FIG. 6.

FIG. 8 is a sectional view similar to FIG. 5, showing the inner member as a metallic elongated slug and the outer member as an electromagnet.

FIG. 9 is a sectional view taken as on the line IX—IX of FIG. 8 but showing the inner member as a permanent magnet and the outer member as a metallic ring.

FIG. 10 is a sectional view taken as on the line X—X of FIG. 9.

FIG. 11 is a sectional view similar to FIG. 10 but showing the inner member as a non-magnetic cannister filled with granules of a metallic substance and the outer member as a permanent magnet.

FIG. 12 is a sectional view also similar to FIG. 10 but showing the inner member as a metal sphere and the outer member as a permanent magnet.

FIG. 13 is a view similar to FIG. 9 except showing the embodiment of FIG. 12.

FIG. 14 is a side elevational view of a fourth embodiment which is similar to the principal embodiment but showing a steam generator for initially causing the slug to move along the tube and additional steam generators downstream from the initial one to provide a booster means for causing the slug to continue to move along as the pressure from the initial one diminishes.

FIG. 15 is an enlarged sectional view taken as on the line XV—XV of FIG. 14 showing structure for cooling and drying the steam to cause a turbulent tornado action within the tube.

FIG. 16 is a sectional view taken as on the line XVI—XVI of FIG. 15.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1 wherein the conveying means 11 of the present invention is shown to move an object or cause a force to act horizontally, the conveying means 11 includes a tube 13, which is shown as a cylindrical tube, although it may be other shapes, such as being square in cross section, without departing from the spirit and scope of the present invention. An inner member or slug 15 is slidably mounted in tube 13 with O rings 17 or the like being mounted in grooves, not shown, in slug 15 to form a seal between slug 15 and

the interior of tube 13 to prevent fluid from passing between slug 15 and the tube 13. Slug 15 is preferably formed from a metal which is not permanently magnetized, e.g., a non-magnetized piece of steel or ferromagnetic substance, but may be permanently magnetized, if desired, e.g., having an opposite polarity with respect to the magnet 33 for increasing the coupling force therebetween. Slug 15 is preferably, though not necessarily, tapered as at 19 and 21 adjacent the opposite ends thereof. In the example shown in FIG. 1, the slug 15 is circular in cross section, although it will be understood that the cross sectional shape of the slug should preferably correspond to the cross sectional shape of the tube 13.

A fluid system 23 is provided for supplying fluid to tube 13 to move slug 15. Thus, in the example shown in FIG. 1, fluid system 23 includes a reservoir 25 containing hydraulic fluid 27 and a pump 29 interposed in a suitable conduit 31 leading from the reservoir 25 to one end of tube 13 for supplying hydraulic fluid under pressure to one end (the end to the left in FIG. 1) of slug 15 so that the slug 15 moves to the right, as viewed in FIG. 1, along the tube 13. It will be understood, of course, that if desired, a more elaborate fluid system 23 may be provided without departing from the spirit and scope of the present invention, for example, to reverse or stop the slug 15 additional conduits, valves, etc., not shown, well known to those skilled in the art, may be provided.

An outer member, preferably in the form of a magnet 33 is slidably mounted on the exterior of tube 13 adjacent slug 15 to provide a magnetic field F in which slug 15 is disposed so that as slug 15 moves along tube 13, magnet 33 will move along with the slug 15 and provide a horizontal force 34. This force 34 can be utilized to move an object 35 either directly or through a plate 37 attached to and supported by magnet 33, and which plate 37 is also itself an object. It will be understood that with the plate 37 disposed as shown in FIG. 1, object 35 should be fixed thereto by suitable means, not shown. Also, any other desired work may be done by force 34, as by the force acting to pull or push any desired object.

Magnet 33 is preferably an electro-magnet having the usual coils 41 energized through conductors such as conductors 43 by a source of electricity connected thereto, as battery 45. It will be understood that to disconnect magnet 33 from slug 15, it is only necessary to open switch 47 which is interposed in conductors 43. Also, it will be understood that, if desired, magnet 33 may be a permanent magnet, without departing from the spirit and scope of the present invention. In addition, it should be pointed out that tube 13 is formed of a non-magnetic substance, e.g., aluminum, for allowing free passage of lines of force therethrough to couple the slug 15 with the magnet 33.

Referring now to FIG. 2, there is shown the conveying means 11 of the present invention in another application, that is, being used as an elevator, in which case the tube 13 is disposed in a vertical position to raise and lower the object 35. The fluid system 49 is more elaborately shown for causing upward and downward movement of the slug 15. Thus, fluid system 49 includes a pump 51 for pumping the fluid, as hydraulic fluid, compressed air or the like, and suitable conduits shown, with valves 53, 55, 57, 59 and 61 interposed therein, for directing the fluid to the upper or lower end of the slug 15 to move the slug upwardly or downwardly. Thus, it will be understood that with pump 51 pumping in the direction shown, and with the valves 55 and 57 being closed and with valves 53, 59 and 61 being open, the slug 15 will move upwardly to carry magnet 33, plate 37 and object 35 upwardly. Then, it will be understood that if it is desired to stop the movement of slug 15, plate 37 and object 35, the valves 53, 55 and 61 are closed and valves 57 and 59 are disposed in an open position to bypass the fluid back to the pump 51. Also, when it is desired to lower slug 15, plate 37 and object 35, valves 53 and 59 are closed and valves 55, 57 and 61 are opened. In addition, it will be understood that magnet 33 may be released from following the movements of slug 15 by opening switch 47.

Referring now to FIG. 3, which shows a modification of the present invention in which the inner member is in the form of a magnet 63 in the interior of tube 13 and the outer member is in the form of metallic slug 65 on the exterior of the tube 13, magnet 63 is in the form of a permanent magnet although it may be in the form of an electro-magnet without departing from the spirit and scope of the present invention. Slug 65 is preferably formed from a metal which is not permanently magnetized, e.g., a non-magnetized piece of steel or ferromagnetic substance, but may be permanently magnetized, if desired, i.e., having an opposite polarity with respect to the magnet 63 for increasing the coupling force therebetween. Slug 65 is preferably annular in shape and slidably mounted on the exterior of tube 13. If it is desired to reduce friction, slug 65 may be provided with non-magnetic rollers, not shown, engaging the outer surface of tube 13. The remaining portions of the system, not shown, in FIG. 3 may be as previously disclosed for the embodiments of FIGS. 1 and 2, and may be utilized for conveying, elevating, or force producing purposes in the same manner as that described for the embodiments of FIGS. 1 and 2.

FIGS. 6 and 7 of the drawings depict a third embodiment of the present invention character referenced therein by the numeral 211 and herein described as a conveying and rotary force producing assembly. The assembly 211 includes at least one unit 212, as depicted in FIGS. 4 and 5 of the drawings, comprising an endless tube 213 similar to the tube 13 but having the shape of a ring, as clearly shown in the drawings. Additionally, a plurality of spaced apart inner members or a first set of members 215 are provided and are received within the endless tube 213. The inner members 215 are fixedly attached one to the other by a plurality of arcuate shafts 216 to establish a predetermined spaced interval therebetween for reasons yet to be disclosed.

The endless tube 213 preferably is provided with a plurality of inlet conduits 217, 217', 217'' and a plurality of outlet conduits 219, 219', 219''. An intake manifold 218 is included and communicates the inlet conduits 217, 217', 217' one with the other. An exhaust manifold 220 is included which communicates the outlet conduits 219, 219', 219'' one with the other. A fluid system 223 is provided for supplying fluid to the intake manifold 218, thence to the endless tube 213 to move the first set of members or inner members 215. The fluid system 223 may be somewhat similar to the previously described fluid system 23 or it may be in the form of a steam generator or the like. In other words, the endless tube 213 may be suitably adapted for receiving steam to drive the inner members 215 or it may be





adapted to receive other fluids, e.g., hydraulic fluid or the like. Accordingly, the fluid system 223 will be constructed in accordance with procedures well known to those skilled in the art pertaining to the particular fluids selected. However, it should be pointed out that the endless inner and adjacent structure, e.g., manifolds 218, 220, should be constructed from a non-magnetic substance which will readily allow uninterrupted passage of magnetic lines of force. Additionally, the inlet conduits 217', 217'' or the outlet conduits 219', 219'' may optionally be deleted from the unit 212 without departing from the spirit and scope of the present invention. In this event, it would be obvious to delete the appropriate manifold 218 or 220 also.

The unit 212 also includes a suitably journaled shaft 225 which is received within the ring formed by the endless tube 213 and with the endless tube 213 being concentric to the shaft 225. A plurality of spaced apart outer members or a second set of members 227 are provided and are fixedly attached to the shaft 225. More specifically, a plurality of spokes 229 are included which radiate outwardly from the shaft 225 with the inner ends thereof being fixedly attached to the shaft 225, as by welding or the like. The respective outer member 227 are fixedly attached to the outer ends of the spokes 229, as by welding or the like. The second set of members 227 are disposed adjacent the exterior of the endless tube 213 at locations along the circumference thereof which respectively are in proximity to the first set of members 215. In other words, the predetermined spaced interval of the inner members 215 alluded to above corresponds to the spaced apart distance of the second set of members 227. Either the first set of members 215 or the second set of members 227 constitute magnets for respectively magnetically coupling the other set of members therewith to cause the second set of members 227 to move along with the first set of members 215, thus a rotary force is imparted to the shaft 225.

From FIGS. 4 and 5 of the drawings, it may be seen that the first set of inner members 215 have an elongated cylindrical shape thereto. members 215 are preferably formed from a metal which is not permanently magnetized, e.g., a non-magnetized piece of steel or ferro-magnetic substance, but may be permanently magnetized, if desired, i.e., having an opposite with respect to the outer member 227. Additionally, the second set or outer members 227 preferably are individually formed from a plurality of permanently magnetized ferromagnetic substances 227*a* – 227*g* which may be suitably arranged to have the magnetic forces thereof additive and establishing an opening 231. The opening accommodates the inlet and outlet conduits 217, 219 as well as suitable support structure, e.g., brace members 232 preferably formed from a non-magnetic substance. In other words, the brace members 232 may pass through the openings 231 to support the endless tube 213 in a fixed disposition with respect to suitable frame structure (not shown).

From FIGS. 6 and 7 of the drawings, it may be seen that the assembly 211 includes at least a plurality of endless tubes 213, 213', and 213''. The plurality of endless tubes 213, 213', 213'' are arranged one behind another and have the respective spokes 229, 229', 229'' fixedly attached to the common shaft 225 which increases the force being produced therewith. It should be pointed out that the endless tubes 213, 213', 213'' respectively have intake manifolds 218, 218', 218'' and exhaust manifolds 220, 220', 220'' communicated therewith, i.e., substantially as above disclosed for the manifolds 218, 220. From FIG. 6 of the drawings, it may be seen that the intake manifolds 218, 218', 218'' communicate with a common intake manifold 218'' and the exhaust manifolds 220, 220', 220'' communicate with a common exhaust manifold 220'''. Further, the preferred arrangement of the outer members 227, 227', 227'' is depicted in FIG. 7. The tubes 213', 213'' each have inner members (not shown) substantially identical to the structure above described for the inner members 215.

An optional arrangement of the above-disclosed structure is depicted in FIG. 8 of the drawings. In other words, the outer members may comprise electromagnets 233 similar to the electro-magnet 33 previously described in the principal embodiment. In other words, the electro-magnet 233 has the usual coils 241 energized through conductors such as conductors 243 by a source of electricity connected thereto, as battery 245. It will be understood that to disconnect magnet 233 from the inner member 215, it is only necessary to open switch 247 which is interposed in conductors 243.

In this regard, it should be understood that the inner members 215 may optionally be spherical shaped without departing from the spirit and scope of the present invention.

Another optional arrangement of the above-disclosed structure is depicted in FIGS. 9 and 10 of the drawings wherein the inner members 263 are formed from a metal which is permanently magnetized, e.g., a permanently magnetized piece of steel or ferromagnetic substance, and outer members 265 are formed from a non-magnetized piece of steel or ferromagnetic substance. Alternatively, outer members 265 may be formed from a permanently magnetized metal, i.e., having an opposite polarity with respect to inner members 263 for increasing the coupling force therebetween. Therefore, the outer members 265 are magnetically coupled to the inner members 263 and move along therewith in the same manner as the previously described inner and outer members 63, 65.

In this regard, it should be pointed out that the inner members 215 and/or 263 constitute elongated slugs having leading and trailing ends as depicted in FIG. 9 of the drawings by the respective numerals 267, 269, i.e., the direction of rotation of the unit 212 being counterclockwise, as when viewed in FIG. 4 of the drawings. More specifically, the inner members 215 and/or 263 have inner and outer sides 271, 273 thereto. The inner side 271 is directed toward the journaled shaft 225 and the outer side is remote therefrom. Additionally, the leading ends 267 are convex-shaped, having a non-regular radius curvature thereto, i.e., the radius gradually increases from a point adjacent the longitudinal centerline of the slugs 215, 263 toward the outer side 273 thereof and the radius curvature gradually decreases from the longitudinal centerline toward the inner side 271. In other words, the convex leading ends 267 have a somewhat teardrop cross sectional shape thereto substantially as depicted in FIG. 9 of the drawings. Additionally, the trailing ends 269 have a concave shape or a regular radius curvature thereto substantially as depicted in FIG. 9 of the drawings.

Another optional arrangement of the above disclosed structure is depicted in FIG. 11 of the drawings wherein the first set of members or inner members may constitute non-magnetic cannisters 275, e.g., the cannisters 275 may be formed from aluminum or the like. The cannisters 275 are filled with granules of a magnetic substance 277, e.g., soft iron or the like. In other words, the cannister 275 would be less susceptible to wear than the soft iron 277. Additionally, it should be understood that the inner members may be formed from a magnetic substance, e.g., soft iron or the like, having a cladding of extremely wear resistant material thereabout, e.g., steel or the like.

In this regard, it should be pointed out that centrifugal force causes the inner members to tend to be thrown outwardly from the shaft 225, i.e., creating additional wear on the outer sides 273 thereof. Therefore, it may be desirable, in order to compensate for a given centrifugal force, to concentrate the magnetic force of the outer members 227 adjacent the spokes 229. More specifically, I anticipate that certain of the magnets depicted in FIG. 5 of the drawings may be omitted without departing from the spirit and scope of the present invention, e.g., the magnets 227*d*, 227*e*, 227*f*, 227*g*. It should be understood that the magnetic force of the remaining magnets, e.g., 227*a*, 227*b*, 227*c* would be calculated to counteract the centrifugal force of the inner member 215 at a specified rpm of the shaft 225 in a manner obvious to those skilled in the art. In other words, the outer members 227 are magnetized so that the poles are spaced radially, e.g., the south pole adjacent the inner side of the magnet and the north pole adjacent the outer side. Also, the same principle is preferably applied to the electro-magnet 233. In other words, the magnet 233 may be wound in a manner known to those skilled in the art so that the magnetic force will counteract the centrifugal force.

I anticipate that under certain conditions it may be desirable that the inner members be spherical in shape, i. e., like the member 278 depicted in FIGS. 12 and 13 of the drawings. Like inner members 215, which are attached one to the other by a plurality of arcuate shafts 216, the spherical members 278 are intercoupled by a plurality of arcuate shafts 216′ to maintain the spacing between spherical members 278. However, the coupling between shafts 216′ and spheres 278 is such that the spheres are adapted to rotate so that they can roll on the interior of tube 213. Thus, at the ends of shafts 216′ are respectively provided rings 279 fixedly attached to shafts 216′ by supports 280, and which rings 279 have sockets 279′ shaped to conform to the curvature of spheres 278 so that the spheres can easily rotate therein. It will be noted that rings 279 are smaller in diameter than spheres 278 and fit on the opposite sides of the spheres with the rings being spaced from the interior surface of tube 213. It will be understood that, if desired, shafts 216′, supports 280, and rings 279 may be omitted without departing from the spirit and scope of the present invention. Additionally, it should be pointed out that the outer members 227 depicted in FIGS. 11, 12 and 13 of the drawings are preferably formed from a permanently magnetized metal, e.g., steel or a ferro-magnetic substance having lines of force coupling the appropriate inner member thereto, i.e., granules of soft iron 227 or spherical shaped member 279. However, it should be pointed out that either the inner member or the outer member or both may be magnets without departing from the spirit and scope of the present invention.

A fourth embodiment of the present invention is depicted in FIGS. 14 – 16 of the drawings and is character referenced therein by the numeral 311. The fourth embodiment 311 is somewhat similar to the principal embodiment 11 in that the tubular member 313 is substantially straight and has an indefinite length thereto. In fact, it is anticipated that the tubular member 313 may extend from one distant point to another, as for example, from one city to another for reasons yet to be disclosed. An inner member 315 is slidably received in the tubular member 313. Inner member 315 preferably is formed from a metal which is not permanently magnetized, e.g., a non-magnetized piece of steel or ferro-magnetic substance, but may be permanently magnetized, if desired, as heretofore explained relative to the other embodiments. The inner member 315 has a shape thereto substantially like that previously disclosed for the inner member 263 except the inner member 315 would have a cylindrical shape, i.e., straight sides rather than curved. Therefore, it would be redundant to describe in detail the shape of the inner member 315. Also, it will be understood that inner member 315 may be other shapes, e.g., like sphere 278, without departing from the spirit and scope of the present invention. Also, it will be understood that more than one inner member 315 (or sphere 278) may be provided with or without shafts 216 (or 216′), without departing from the spirit and scope of the present invention.

In order to have a complete understanding of the forces acting upon the inner member 315 (or 278), a complete understanding of tornadoes would be beneficial. A complete dissertation on tornadoes will not be attempted herein; however, a few important aspects thereof will be cited. First, tornadoes are formed under specific unstable atmospheric conditions involving layers of air with contrasting temperatures, moisture contents, densities, and wind flows. Secondly, complicated energy exchanges within these unstable air systems produce the vortex, which is the whirling funnel of rotating winds. Third, researchers seem to agree that tornadoes are caused by the combined effects of two kinds of forces, e.g., thermal or those involving the transfer of heat and mechanical or those involving rotating winds. Fourth, the exact process of tornado formation is still in doubt, but the following is generally accepted as factual:

A warm, moist surface air, having a natural tendency to rise, is prevented from rising by a mass of cold air pushing down on it. This sets up a condition of imbalance that is violently adjusted by a sudden breakthrough of the warm air at a particular location in the cold air mass. After this breakthrough, the warm lower air forces its way upward and the heavier cool air drops down, thus a rotary flow of air is created that may form into a tornado vortex. Wind currents spinning inward and upward create the vacuum at the eye or center. The violent whirling action of the wind's inward and upward movement is the main characteristic of a tornado.

Referring again to FIGS. 14 and 16 of the drawings, it may be seen that the fourth embodiment 311 includes a means 317 for introducing a non-stable turbulent mass of fluid into the tubular member 313 at least at one location along the length thereof to slidably move the inner member 315 (or 278) along the tubular





member 313. The means 317 includes a steam generator 319 which delivers steam under pressure through a conduit 321 to the interior of the inner member 315. From FIG. 14 of the drawings, it may be seen that the conduit 321 joins the tubular member 313 at an angle which causes the steam to be concentrated at a downstream point 323 within the tubular member 313. A conduit 325 also communicates the steam generator 319 with the tubular member 313. However, the steam from the steam generator 319 passes through a cooling section 327 which is clearly illustrated in FIGS. 15 and 16 of the drawings. Accordingly, the steam emanating from the steam generator 319 is drastically cooled and preferably has some of the moisture removed therefrom in a manner yet to be described. It should be noted that the cooling section 327 is connected to the tubular member 313 at a location substantially directly above the point 323, therefore setting up the two kinds of forces above-described. In other words, the hot steam adjacent the point 323 having a normal tendency to rise is prevented from doing so by the lid formed by the cooler drier fluid emanating from the cooling section 327. Therefore, a condition of imbalance is established or a non-stable turbulent mass of fluid is introduced into the tubular member 313 which creates a force for driving the inner member 315 (or 278) along.

From FIG. 14 of the drawings, it may be seen that at a predetermined distance downstream along the length of the tubular member 313 a second means 317 for introducing a non-stable turbulent mass of fluid is included, in other words, confining a tornado type situation within tube 313. Additional means 317 (not shown) may be included, depending upon the length of the tubular member 313. An object 329 may be placed adjacent the tubular member 313 and magnetically coupled to the inner member 315 and caused to move along adjacent the tubular member 313 in a manner similar to the previous embodiments. Thus, either the inner member of the outer member may be in the form of a magnet or both may be. It is anticipated that the object 329 might be a passenger conveying device, e.g., monorail structure or a vehicle similar to an automobile. Therefore, the object 329 may be moved from one city to another without conventional prime movers or the like.

The cooling section 327 includes a reduced diameter portion or venturi 331 which has a plurality of stublike tubular members 333 communicated therewith as clearly shown in the drawings. Accordingly, the reduction in pressure through the cooling section 327 will cause the steam to lose moisture and the tubular members 333 will admit cooler dry air which is carried on into the tubular member 313. If desired, cooling sections 327 may be omitted without departing from the spirit and scope of the present invention.

It should be understood that the inner member 315 (or 278) may optionally be an electro-magnet without departing from the spirit and scope of the invention. In other words, electrical structure well known to those skilled in the art could be installed within the tubular member 313 for keeping the inner members 315 (or 278) energized as it travels along the length of the tubular member 313. It should be understood that the inner member 315 travels from right to left, as viewed in FIG. 14 of the drawings.

Although the invention has been described and illustrated with respect to preferred embodiments thereof, it is to be understood that it is not to be so limited since changes and modifications may be made therein which are within the full intended scope of the invention.

I claim:

1. A conveying and force-producing means comprising tube means, at least one inner member movably mounted in said tube means, fluid means for causing fluid to be supplied to said tube means on one end of said inner member to move said inner member, at least one outer member disposed adjacent the exterior of said tube means at a location along the length thereof which is in the proximity of said inner member, magnetic means for magnetically coupling said outer member to said inner member to cause said outer member to move along with said inner member.

2. A conveying and force-producing means comprising tube means, an inner member slidably mounted in said tube means, fluid means for causing fluid to be supplied to said tube means on one end of said inner member to move said inner member, an outer member slidably mounted on the exterior of said tube means adjacent said inner member, magnetic means magnetically coupling said outer member to said inner member for moving said outer member.

3. The conveying and force-producing means of claim 1 in which said outer member includes magnet means, in which said inner member includes a magnetic substance, and in which said magnet means and said magnetic substance comprise said magnetic means.

4. The conveying and force-producing means of claim 1 in which said inner member includes magnet means, in which said outer member includes a magnetic substance, and in which said magnet means and said magnetic substance comprise said magnetic means.

5. The conveying and force-producing means of claim 2 in which said magnetic means includes an energized electro-magnetic means and in which is included means for de-energizing said electro-magnetic means.

6. The conveying and force-producing means of claim 1 in which said tube consists of a non-magnetic substance.

7. The conveying and force-producing means of claim 1 in which is included means for introducing a non-stable turbulent mass of fluid into said tube means at least at one location along the length thereof to move said inner member.

8. A rotary force-producing assembly comprising at least one endless tube, at least one inner member movably mounted in said tube means, fluid means for causing fluid to be supplied to said tube means to move said inner member around said endless tube, at least one outer member disposed adjacent the exterior of said tube in proximity to said inner member, magnetic means for magnetically coupling said outer member to said inner member to cause said outer member to move along with said inner member.

9. A rotary force-producing assembly including at least one unit comprising an endless tube, a plurality of spaced apart inner members constituting a first set of members and being received within said endless tube, at least one inlet conduit and at least one outlet conduit respectively communicated with said tube, means for forcing a fluid into said inlet conduit, said fluid travel-

ing through a portion of said endless tube and being exited through said outlet conduit to cause said first set of members to move along said endless tube, a journaled shaft, said endless tube being disposed circumjacent said shaft with the longitudinal axis of said endless tube being concentric to said shaft, a plurality of spaced apart outer members constituting a second set of members, said second set of members being fixedly attached to said shaft and being disposed adjacent the exterior of said tube at locations along the circumference thereof which respectively are in proximity to said first set of members, magnetic means for magnetically coupling said first and second sets of members together to cause said second set of members to move along with said first set of members which impart a rotary force to said shaft.

10. The assembly of claim 9 in which is included means for interconnecting said first set of members one to the other to establish a fixed interval therebetween, said interval corresponding to the spaced apart distance of said second set of members.

11. The assembly of claim 9 in which said inner members are each spherically shaped, and in which interconnecting means is included for interconnecting said first set of members one to the other to establish a fixed interval therebetween, said interconnecting means including ring means respectively movably coupled to said inner members to permit rolling movement of said inner members.

12. The assembly of claim 9 which includes means for coupling at least a plurality of said units one to the other, said plurality of units being arranged one behind another and being ganged to said journaled shaft to increase the force produced therewith.



13. The assembly of claim 9 in which said first set of members includes magnet means, in which said second set of members includes a magnetic substance, and in which said magnet means and said magnetic substance comprise said magnetic means respectively.

14. The assembly of claim 9 in which said second set of members includes magnet means, in which said first set of members includes a magnetic substance, and in which said magnet means and said magnetic substance comprise said magnetic means respectively.

15. The assembly of claim 14 in which said first set of members respectively comprises non-magnetic canisters for receiving granules of a magnetic substance.

16. The conveying and rotary force producing assembly of claim 9 in which said magnetic means includes of an energized electro-magnetic means and in which is included means for de-energizing said electromagnetic means.

17. The conveying and rotary force-producing assembly of claim 9 in which said inner members constitute elongated slugs having leading and trailing ends thereto, said leading ends being convex-shaped and said trailing ends being concave shaped, said elongated slugs having inner and outer sides thereto with said inner side being directed towards said journaled shaft and said outer side being remote therefrom, said convex end of said slugs having a non-regular radius curvature thereto with the radius gradually increasing from a point adjacent the longitudinal centerline thereof towards said outer side and the radius curvature gradually decreasing from said point adjacent the longitudinal centerline towards said inner side.

* * * * *



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STATE OF NEW YORK )
CITY OF NEW YORK :
COUNTY OF NEW YORK )

## CERTIFICATION

This is to certify that the following is, to the best of our knowledge and belief, a true and accurate translation into ENGLISH of the attached document(s) relating to:

Transport device of a pneumatic dispatch type

written in German.

NEWTYPE COMMUNICATIONS, INC.

Sworn to and subscribed before me
this 2nd day of July, 1997.

NOTARY PUBLIC

MICHAEL A. PRESTIA
Notary Public, State of New York
No. 41-3157725
Qualified in Queens County
Commission Expires May 31, 1999

SA22081

[handwritten:] G 77 26 087.8

August 10, 1977
D 5578 - fual

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Festo-Maschinenfabrik Gottlieb Stoll, 7300 Esslingen

# Transport Device of a Pneumatic Dispatch Type

## Claims

1. Transport device of a pneumatic dispatch type with a tube, in which a piston-like part can be moved back and forth between an initial position and specific intermediate and/or end positions, by means of a preferably pneumatic pressure medium, where the load to be transported is moved along with the part, characterized in that a carriage (21) is guided to move back and forth on the outside





circumference of the tube (12) made of non-magnetic material, and that the piston-like part (13) and the carriage (21) have an inside and an outside magnet (17, 27), respectively, which magnets cause a movement coupling of the two movable parts.

2. Device according to Claim 1, characterized in that the magnets (17, 27) are guided to be contact-free with regard to the tube wall.

3. Device according to Claim 1 or 2, characterized in that the inside or outside magnet (17, 27) is or they are structured as a closed magnet ring or a magnet ring (17, 27) slit on one side, where the magnet rings are coaxial to one another.

4. Device according to one of the preceding claims, characterized in that the carriage (21) is structured as a ring which is slit on one side, and possesses preferably three pairs of rollers (22, 23) uniformly distributed over the circumference.

5. Device according to Claim 4, characterized in that the carriage (21) is provided, on the top or the bottom, with a holder (21) [sic] for the load (28) to be transported.

6. Device according to Claim 4 or 5, characterized in that the carriage (21) is slit in a circumference region in which supports (14) engage with the tube (12).

7. Device according to one of the preceding claims, characterized in that the piston-like part (13) is provided on both ends with ring seals (18) which rest against the inner tube wall and have a radial action.

8. Device according to one of the preceding claims, characterized in that the magnets (17, 27) are structured as permanent magnets and/or adjustable electromagnets.



[handwritten:] G 77.26 087.8

August 10, 1977

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# Transport Device of a Pneumatic Dispatch Type

The invention relates to a transport device of a pneumatic dispatch type with a tube, in which a piston-like part can be moved back and forth between an initial position and specific intermediate and/or end positions, by means of a preferably pneumatic pressure medium, where the load to be transported is moved along with the part.

In the known so-called pneumatic dispatch devices, sleeves which can be closed are provided, into which the object to be transported is inserted, and which are then transported to a different end

position by means of a pneumatic pressure medium. These devices have the disadvantage that the objects to be transported are very limited in terms of volume. Furthermore, opening and closing of the transport aid is relatively time-consuming and complicated. Such pneumatic dispatch devices are therefore only used for transport of papers, etc., over relatively long distances within a building. For short distances and for transport of heavier and larger loads, for example for in-house transport from one job site to another, devices are known which are driven, for example, by means of a pneumatic cylinder or by means of a chain, via a drive motor. However, pneumatic cylinders have the disadvantage that they can be efficiently used only to a lifting height of about 2 meters. Chain drives and similar devices have the disadvantage that they are very noisy in operation.

It is a task of the present invention to create a transport device of a pneumatic dispatch type, of the type indicated initially, with which relatively large objects can be transported back and forth without any problems, for example for purposes of in-house work sequences.

To accomplish this task, it is provided, according to the invention, that a carriage is guided to move back and forth on the outside circumference of the tube made of non-magnetic material, and that the piston-like part and the carriage have an inside and an outside magnet, respectively, which magnets cause a movement coupling of the two movable parts.





The device according to the invention can therefore possess a similarly uncomplicated structure as that of a pneumatic dispatch device, but is practically unlimited with regard to the objects and loads to be transported. The device according to the invention can be used, for example, for in-house transport from one job site to another, for example in the form of a slanted elevator or in another manner. Furthermore, it produces little noise and presents itself as a closed system, in contrast to the known pneumatic dispatch system, in terms of the pneumatic drive medium, so that it can have a very simple structure and there are no sealing problems.

Further details and forms of the invention are contained in the following description, in which the invention is described and explained in greater detail on the basis of the exemplary embodiment shown in the drawing. This shows:

Fig. 1 a crosswise cross-section through the transport device according to an exemplary embodiment of the present invention, and

Fig. 2 a lengthwise cross-section through the transport device according to Fig. 1.

[Translator's Note: The above description of the figures does not match the figures themselves; Fig. 1 shows a lengthwise cross-section, Fig. 2 a crosswise cross-section.]

The transport device 11 of a pneumatic dispatch type according to the invention possesses a tube 12 made of a non-magnetic material, within which a piston-like part 13 can be moved back and forth in the direction of the arrow A, under the effect of a hydraulic or pneumatic pressure medium, preferably compressed air. The guide tube 12, which can possess a relatively small inside diameter of about 25 mm, can have almost any desired type of path. For example, it can be guided and structured along a straight stretch, along a loop, level, inclined, or in any other manner. In the case of longer distances, it is practical to support the guide tube 12 at a constant distance with a support 14, as is evident from Fig. 2.

The piston-like part 13 possesses a core 16 made of non-magnetic material, around which a magnet ring 17 is arranged. On both face ends of the magnet ring 17, the core 16 is surrounded by ring seals 18 which have a radial effect, and which rest against the inside wall of the tube 12, forming a seal, and at the same time serve to guide the part 13. In this connection, the arrangement of the individual elements of the part 13 is determined in such a way that the magnet ring 17 possesses a slight ring gap relative to the inside wall of the tube 12, in other words is held inside the guide tube 12 in contact-free manner. The core 16 forms the engagement surface for the preferably pneumatic pressure medium on its two faces 19.





On the outside circumference side, the guide tube 12 is surrounded by a carriage 21, which has the shape of a slit ring and is also made from non-magnetic material. The carriage 21 possesses a front and rear roller 22, 23, which act as transport and guide rollers, with which the carriage 21 can easily be moved along the length of the tube 12. The rollers 22, 23 are directed radially, with their axes of rotation 24 being arranged crosswise to the direction of movement. In the circumference region of the supports 14 which engage with the tube 12, the carriage 21 is provided with a slit 26, which preferably runs at a slant downward, preferably at an acute angle to the perpendicular. On the inside circumference side, an outside magnet ring 27 is held on the carriage 21, which ring is arranged coaxial to the inside magnet ring 17 and represents a counter-magnet to the latter. The outside magnet ring 27 is also held in such a way that its inside circumference forms a gap with the outside circumference of the tube 12, so that it is held in contact-free manner with regard to the tube 12. In the exemplary embodiment shown, the load 28 is held, i.e. attached by means of a suitable holder device 29, hanging down from the carriage 21. It is understood that a corresponding holder device can also be provided on the top, the side, or any other part of the circumference of the carriage 21. It is also possible to affix one or two holder devices on the face(s) of the carriage.

The two magnet rings 17 and 27 are attuned to one another in such a way that practically rigid coupling of the carriage 21 with the pneumatically driven part 23 [sic] is obtained, so that the carriage 21 is moved back and forth synchronous with the drive of the inside part 13, for example by means of compressed air. The inside and/or outside magnets 17, 27 can be structured as permanent magnets or also as electromagnets with an adjustable force. It is also possible to combine permanent magnets and electromagnets with one another in such a way that the basic load is taken over by the permanent magnet, while electromagnets can be added or removed as desired for other cases.

It is understood that it is also possible to give the magnets 17 and 27 a different shape. For example, it is possible to provide several magnets arranged to be distributed over the circumference, instead of a ring. It is furthermore also possible to give the carriage 21 a different shape, for example to suspend it from the tube in the manner of a gallows.

It is furthermore understood that the guide tube 12 is structured as a closed system, which is provided with inlet and outlet openings for the pressure medium at both ends. It is also possible, depending on the length of the guide tube, to provide inlets and outlets for the pressure medium, which can be opened and shut, at intermediate stations.



[1 page of drawings, Fig. 1 and 2]

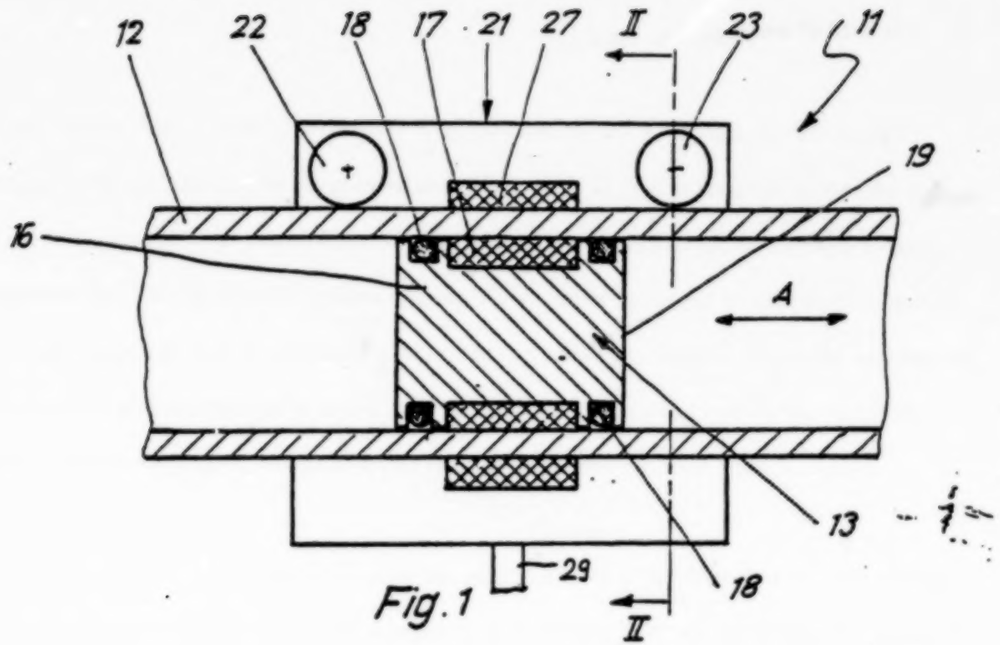
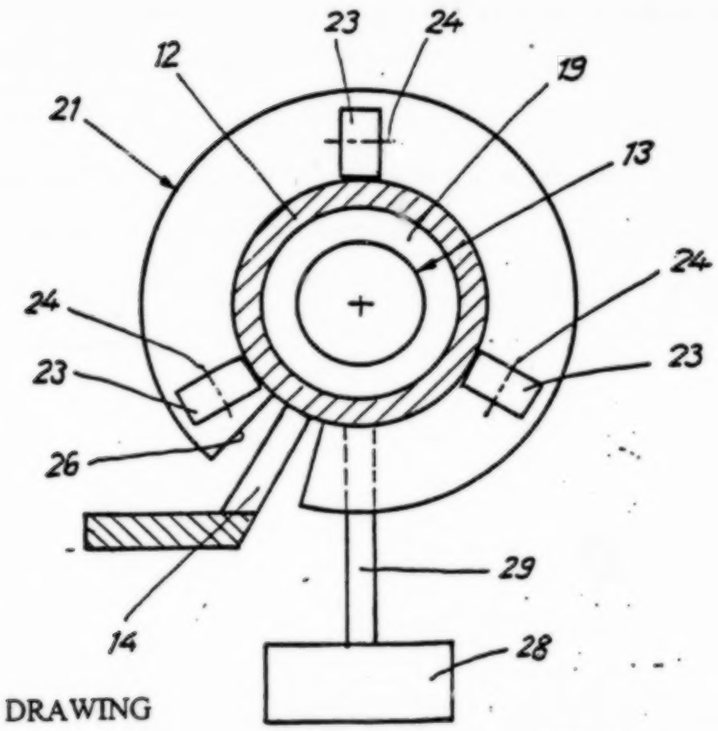



Fig. 1




ORIGINAL SIZE DRAWING

SA22102

Fig. 2



PLAINTIFF'S EXHIBIT 17
ALLSTATE LEGAL SUPPLY CO.

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January 31, 1992
(Date)

THIS IS TO CERTIFY that the annexed is a true copy from the records of this office

of U.S. Patent 3,779,401.

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COMMISSIONER OF PATENTS AND TRADEMARKS

Certifying Officer.

# United States Patent [19]

**Carroll**

[11] **3,779,401**

[45] **Dec. 18, 1973**


[54] **PNEUMATIC DEVICE FOR MOVING ARTICLES**


[76] Inventor: **George Carroll**, 12 Palmerston, Stockport, England



[22] Filed: **Feb. 17, 1972**

[21] Appl. No.: **227,570**

[30] **Foreign Application Priority Data**

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[52] U.S. Cl. ..... 214/1 BB, 91/DIG. 4, 92/169

[51] Int. Cl. ..... F01b 11/00

[58] Field of Search ..... 214/1 BB, 1 BT; 294/65.5; 91/DIG. 4; 92/169, 170



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*Attorney*—Francis C. Browne et al.



[57] **ABSTRACT**

A device for moving articles comprising a cylinder of non-ferrous material, a piston including a magnet movable within said cylinder, means for controlling the admission of pressure fluid to the cylinder for moving said piston and a body disposed outside and adjacent to said cylinder, said body including a magnet, the arrangement being such that movement of said piston causes a corresponding movement of said body.


**8 Claims, 6 Drawing Figures**

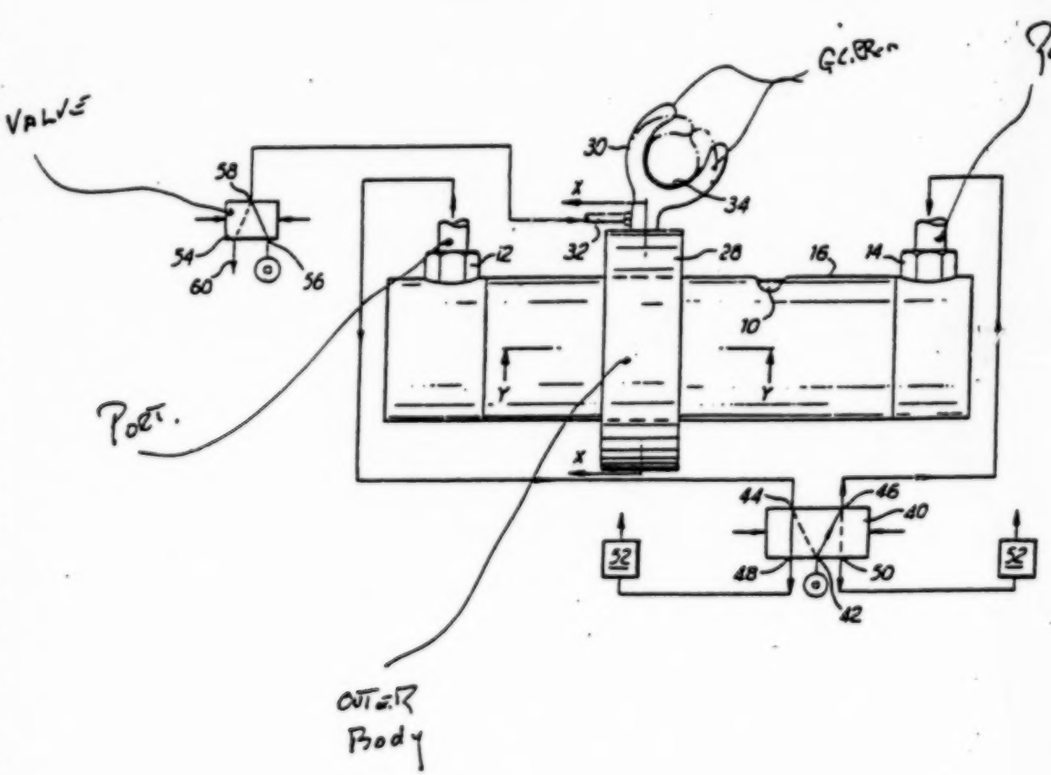







FIG. 1

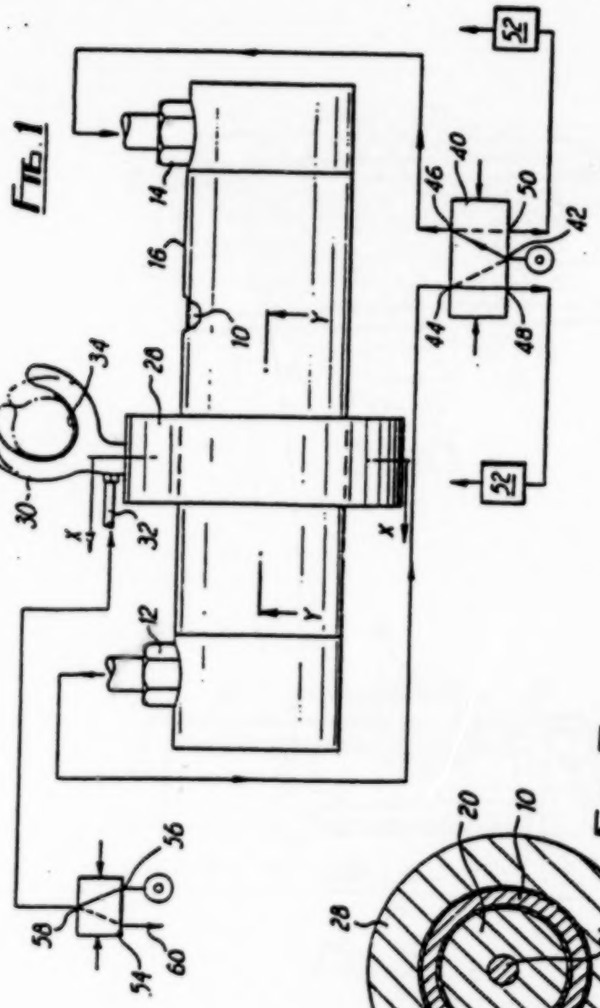
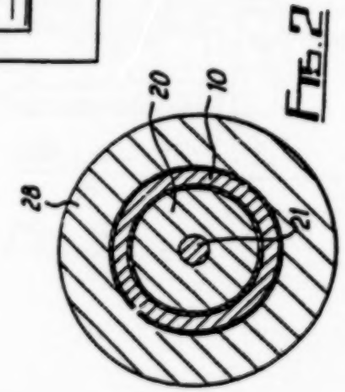



FIG. 2



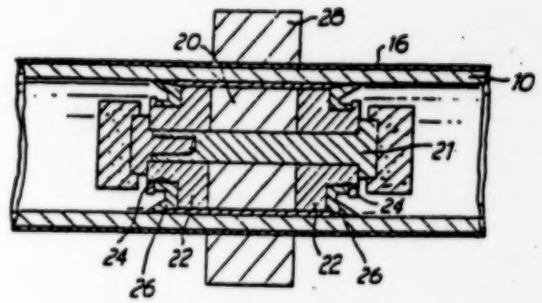



FIG. 3

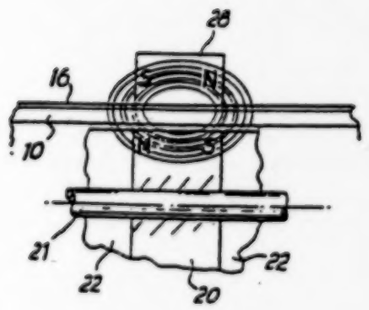



FIG. 4





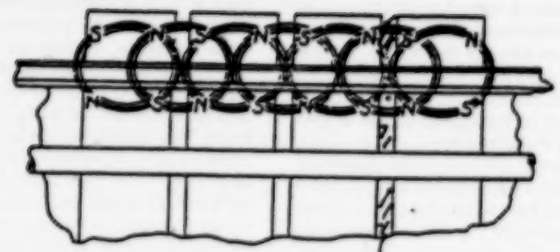


FIG. 5

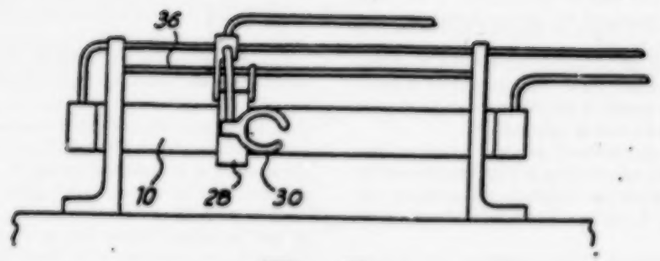



FIG. 6

# PNEUMATIC DEVICE FOR MOVING ARTICLES

This invention relates to a magnetic device for moving articles and in particular for moving articles of clothing.

It has previously been proposed to provide pneumatic devices which include a cylinder and a piston mounted on a piston rod working in said cylinder. Such devices suffer from the disadvantage that considerable space is required to accommodate the piston rod. Such a distance being up to twice the distance through which an article may be moved by the device.

Further, in the clothing industry in particular, very light loads are required to be moved preferably at high speeds or at both high speeds and slower speeds during transfer of an article from one site to . nother. Devices as previously proposed cannot operate in accordance with these requirements.

The present invention has been made from a consideration of the aforesaid disadvantages.

According to the invention there is provided a device for moving articles comprising a cylinder of non-ferrous material, a piston including a magnet movable within said cylinder, means for controlling the admission of pressure fluid to the cylinder for moving said piston and a body disposed outside and adjacent to said cylinder, said body including a magnet, the arrangement being such that movement of said piston causes a corresponding movement of said body.

In a preferred embodiment of the invention the body comprises an annular magnet surrounding the cylinder having means mounted thereon for holding or supporting an article. Inlets for pressure fluid are preferably provided at each end of the cylinder and the input and/or exhaust of pressure fluid to the cylinder is preferably controlled by a valve. Means may also be provided for adjusting the conditions of pressure fluid within the cylinder so that the piston movement can be halted during travel from one end of the cylinder to the other and/or so that the speed of the piston during travel of the cylinder can be varied.

The pressure fluid employed in the present invention is preferably compressed air so that the device is pneumatic. It is however possible for the pressure fluid to be a liquid so that the device is hydraulic.

The invention is particularly adapted to move light loads such as articles of clothing at high speeds and for this purpose the means for holding or supporting the article is preferably a resilient pneumatically operable gripping device.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 shows the device and associated control means schematically;

FIG. 2 is a section on the line X—X of FIG. 1;

FIG. 3 is a section on the line Y—Y of FIG. 2.

FIG. 4 shows the magnetic field using a single magnet;

FIG. 5 shows the magnetic field where a plurality of magnets are employed; and

FIG. 6 shows the device in plan view.

Referring to the drawings the device comprises a cylinder 10 of non-ferrous material having parts 12 and 14 adjacent each end. A coating 16 of material having a low coefficient of friction, such as polytetrafluoroethylene, is formed on both outer and inner surfaces of said cylinder. A piston 18 is located in the cylinder, the piston comprising a cylindrical permanent magnet 20, having a diameter less than the internal diameter of the cylinder 10, clamped between two non-ferrous piston end members 22, of substantially cylindrical shape but of overall diameter less than the internal diameter of the cylinder. The magnet 20 and piston end members are held together by means of a bolt 21 passing through a bore in the magnet and end members.

Each end member has an annular groove 24 thereround which accommodates a resilient sealing ring 26 adapted to engage the inner wall of the cylinder and form a fluid tight seal. Cushions of resilient material are fixed to each end member, or as shown in FIG. 2 to the head of the bolt 21 to prevent damage to the device when the piston reaches the ends of the cylinder.

A permanent magnet 28 of annular shape surrounds the cylinder with minimum clearance, the polarisation of magnets 20 and 28 being such that movement of the piston, and hence magnet 20 within the cylinder causes corresponding movement of magnet 28 outside the cylinder (see FIG.4). piston, and hence magnet 20 within the cylinder causes corresponding movement of magnet 28 outside the cylinder (see FIG.4).

A pneumatically operable article gripping device 30 is mounted on magnet 28. The gripper device 30 comprises a hollow substantially U-shaped body of resilient material, such as rubber, having an inlet 32 for pressure fluid. The U-shaped body is held in shape by means of light porous reinforcing material therewithin. A strip of material 34 is bonded to the body between the arms thereof, said material being material of less elasticity than that of the body so that when pressure fluid is admitted through inlet 32 the arms of the U-shaped body will bend inwards towards each other (as shown in dotted lines in FIG.1) and will grip any article therebetween. In order to prevent the magnet 28 rotating relative to the cylinder a guide rod 36 (FIG.6) is mounted outside the cylinder and axially parallel thereto, a tie bar 38 being fixed to the magnet and having a hole bore therein which runs freely on the guide rod.

The device is controllable by means of a five part spool valve 40 which has a port 42 connected to a supply of compressed air (not shown), port 44 connected to cylinder port 12, port 46 connected to cylinder port 14 and exhaust ports 48 and 50. As shown in FIG. 1 the spool valve is in position to supply compressed air to cylinder port 14 and cylinder port 12 is connected to exhaust port 48 so that the piston, and with it magnet 28 and gripping device 30, is moved to the left (as viewed in the drawing). On reversing the spool valve compressed air will be supplied to cylinder port 12 and cylinder port 14 will be connected to exhaust port 50 so that the piston moves towards the right. The exhaust ports of valve 40 are preferably connected to variable restrictor mechanisms 52 which are automatically operable to control the exhaust from the valve 40 and hence the speed of the piston in the cylinder.

The supply and exhaust of pressure air to the gripping device 30 is controlled by a spool valve 54 having a port 56 connected to a compressed air supply (not shown), a port 58 connected to inlet 32 and an exhaust port 60. The movement of the magnet 28 along the cylinder can be used to generate signals for operating the valve 54 and if desired the restrictor mechanisms 52 and valve 40.

As illustrated in FIG. 5 more than one magnet may be provided on the piston and/or around the cylinder.

It is, however, preferred to arrange that the magnetic force between the magnets should not be greatly in excess of that required to move the articles required to be transported. Thus should magnet 28 be obstructed by a person or by some object the piston can still move to the end of the cylinder without any damage to the device and without injury to the person or object.

The device according to the invention is capable of high speed operation, the speed of travel of the piston in the cylinder being a function of the volume of air admitted through the inlet port and exhausted through the exhaust port, this itself being a function of the size of the ports. By appropriate dimensioning of the ports it has been possible without difficulty to move a piston from one end of a 20 foot cylinder to the other end thereof in about 7 seconds.

The device may be used not only for the transfer of articles of clothing, but may be used to carry any article from one site to another along a predetermined path. Thus while the specific embodiment describes an arrangement suitable for transferring an article along a linear path, it is possible to shape the guide rod for example in the form of a helix so that the body will follow a helical path.

In the embodiment described with reference to the drawings a polytetra fluoroethylene coating is applied to the outer surface of the cylinder to provide a low friction surface upon which the body may run. As an alternative it is possible to provide an air bearing between the body and the cylinder. Further it is possible to use the repulsive force of magnets located in longitudinal grooves in the surface of the cylinder and further magnets disposed in the body which maintain the body spaced - apart from said cylinder.

If the device is designed for operation at high speeds, it may be found that the piston is decelerated too abruptly on reaching the end of the cylinder. Better control over deceleration of the piston may be accomplished by coupling the port which is exhausting to a chamber or cylinder containing a non-compressible fluid such as water.

The operation of the device may be triggered by any suitable means such as a timing device and/or a device sensitive to the presence, at one end of the device, of an article to be transferred thereby.

What is claimed is:

1. A device for moving articles comprising a cylinder of non-ferrous material, a piston including a permanent magnet having a pole-piece on each axial side thereof, a body disposed outside and adjacent to said cylinder, said body including a permanent magnet which substantially surrounds the cylinder, there being a pole piece on each axial side of the permanent magnet included in said body, and means for controlling the admission of pressure fluid into the cylinder and exhaust of fluid from the cylinder for moving the piston in the cylinder, the attractive forces between the permanent magnets being such that movement of the piston causes corresponding movement of the body below a predetermined load on the body and such that above said predetermined load movement of the piston does not cause corresponding movement of the body.

2. A device as claimed in claim 1, wherein the body comprises an annular magnet surrounding the cylinder and means for holding or supporting an article.

3. A device as claimed in claim 2, wherein the means in said body for holding an article comprises a pneumatically operable gripping means.

4. A device as claimed in claim 3, wherein at least a part of the gripping means is adapted to grip an article and is made of resilient material.

5. A device as claimed in claim 1 wherein a port is provided at each end of the cylinder for the input of pressure fluid to, and exhaust of pressure fluid, from the cylinder.

6. A device as claimed in claim 5, wherein a valve is provided for controlling the input of pressure fluid and the exhaust of pressure fluid from the cylinder to thereby control the movement of the piston in the cylinder.

7. A device as claimed in claim 1 in which said body including the permanent magnet surrounds the cylinder.

8. A device as claimed in claim 1 in which the piston includes a plurality of permanent magnets.

* * * * *

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02/3,779,401.PS



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U. S DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

PLAINTIFF'S EXHIBIT 19
ALL-STATE LEGAL SUPPLY CO.

January 31, 1992
(Date)

THIS IS TO CERTIFY that the annexed is a true copy from the records of this office

of the Reexamination Certificate Number B1 3,779,401.

By authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

Certifying Officer.

# REEXAMINATION CERTIFICATE (935th)


**United States Patent** [19]

**Carroll**

[11] **B1 3,779,401**

[45] Certificate Issued **Oct. 25, 1988**


[54] **PNEUMATIC DEVICE FOR MOVING ARTICLES**


[75] Inventor: **George Carroll**, Stockport, England

[73] Assignee: **Festo KG**, Esslingen-Berkheim, Fed. Rep. of Germany



**Reexamination Request:**
No. 90/001,477, Mar. 18, 1988

**Reexamination Certificate for:**

| | |
|---|---|
| Patent No.: | 3,779,401 |
| Issued: | Dec. 18, 1973 |
| Appl. No.: | 227,570 |
| Filed: | Feb. 17, 1972 |

[30] **Foreign Application Priority Data**

Feb. 18, 1971 [GB] United Kingdom ..... 4890/71

[51] Int. Cl.[4] ..... **F01B 11/00**

[52] U.S. Cl. ..... 414/751; 91/DIG. 4; 92/169; 198/619

[58] Field of Search ..... 414/3, 749, 751; 91/DIG. 4; 92/85 R, 169, 170; 198/619; 104/154, 156



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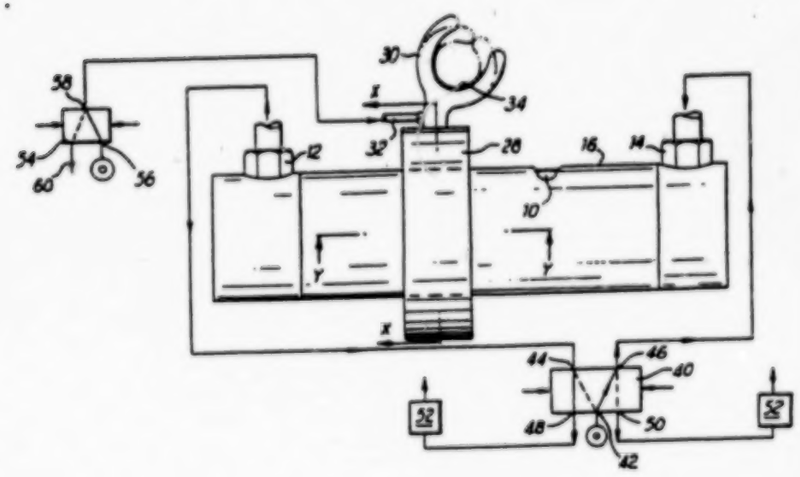
*Primary Examiner*—L. J. Paperner


[57] **ABSTRACT**


A device for moving articles comprising a cylinder of non-ferrous material, a piston including a magnet movable within said cylinder, means for controlling the admission of pressure fluid to the cylinder for moving said piston and a body disposed outside and adjacent to said cylinder, said body including a magnet, the arrangement being such that movement of said piston causes a corresponding movement of said body.






## REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

**Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.**

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

Claims 1, 2, 7 and 8 are cancelled.

Claims 3 and 5 are determined to be patentable as amended.

Claims 4 and 6, dependent on an amended claim, are determined to be patentable.

New claim 9 is added and determined to be patentable.

3. A device as claimed in claim [2] *9* wherein the means [in] *on* said body for holding an article comprises a pneumatically operable gripping means.

5. A device as claimed in claim [1] *9* wherein a port is provided at each end of the cylinder for the input of pressure fluid to, and exhaust of pressure fluid, from the cylinder.

*9. A device for moving articles, which comprises:*

*a hollow cylinder formed of non-ferrous material and having opposite axial ends;*

*a piston mounted in the interior of the hollow cylinder and reciprocatingly slidable therein, the piston including a central mounting member disposed axially in the cylinder, a plurality of cylindrically-shaped permanent magnets mounted on the central mounting member and spaced apart axially from each other, each magnet having a bore formed axially therethrough for receiving the central mounting member, at least one pair of end members mounted on the central mounting member and disposed on opposite axial sides of the plurality of magnets, a pair of cushion members formed of resilient material, the cushion members being situated near opposite axial ends of the central mounting member to help prevent damage to the piston when the piston contacts an axial end of the cylinder, and a pair of resilient sealing rings situated near opposite axial ends of the central mounting member and engaging the cylinder to effect a fluid-tight seal therewith;*

*a body mounted on the exterior of the hollow cylinder and reciprocatingly slidable thereon, the body including a plurality of annularly shaped permanent magnets surrounding the cylinder and spaced apart from each other, the permanent magnets of the piston and body being polarized so as to magnetically couple the body to the piston whereby movement of the piston inside the cylinder causes a corresponding movement of the body outside the cylinder, the body further including means provided thereon for holding on the body an article to be moved; and*

*means for controlling the admission of pressure fluid into the cylinder and exhaust fluid from the cylinder for moving the piston in the cylinder, the attractive forces between the permanent magnets of the piston and the body being such that movement of the piston causes corresponding movement of the body below a predetermined load on the body and such that above said predetermined load movement of the piston does not cause corresponding movement of the body.*

* * * * *

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B1



PLAINTIFF'S EXHIBIT 18

3779401

1504 (8-83)

# RE[X]AMINATION

| CONT[ ] NUMBER | CERTIFICATE DATE | CERTIFICATE NUMBER |
|---|---|---|
| [ ]1477 | OCT 2 5 1988 | B1 3,779,401 |

| SERIAL NUMBER | FILING DATE | CLASS | SUBCLASS | GROUP ART UNIT | EXAMINER |
|---|---|---|---|---|---|
| 90/[ ]477 | 03/13/88 | 414 | 751 | 317 | [redacted] |

APPLICANTS

OW[redacted] PAT NO 3,779,401,,, FESTO K.G., ESSLINGEN, FED REP GERMANY.

**[redacted]UING DATA**********
VE[redacted] THIS APPLN IS A REX OF 05/227,570 02/13/72 PAT 3,779,401

**F[redacted]PCT APPLICATIONS**********
VE[redacted] UNITED KINGDOM 4490 02/13/71

FORE[redacted]ING LICENSE GRANTED 03/10/88

| Foreign priority 35 USC 119 | Yes / No | Yes / No | AS FILED | STATE OR COUNTRY | SHEETS DRWGS. | TOTAL CLAIMS | INDEP. CLAIMS | FILING FEE RECEIVED | ATTORNEY'S DOCKET NO. |
|---|---|---|---|---|---|---|---|---|---|
| Verified and | | Examiner's Initials | → | | 0 | 10 | 1 | $1,770.00 | |

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HOF[redacted] HARON
350[redacted] TURNPIKE
JER[redacted] 11753

TITLE
PNE[redacted] EVICE FOR MOVING ARTICLES

This is to certify that annexed hereto is a true copy from the records of the United States Patent and Trademark Office of the File Wrapper and Contents of the file identified above.

By authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

M. Lee

Certifying Officer

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# ...AMINATION

3779401

| ...NUMBER | CERTIFICATE DATE | CERTIFICATE NUMBER |
|---|---|---|
| 90001477 | OCT 25 1988 | B1-3,779,401 |

| SERIAL NUMBER | FILING DATE | CLASS | SUBCLASS | GROUP ART UNIT | EXAMINER |
|---|---|---|---|---|---|
| 90/001,477 | 05/13/88 | 414 | 751 | 317 | D. [illegible] |

APPLICANTS

OWNER OF PAT NO 3,779,401, FESTO K.G., ESSLINGEN, FED REP GERMANY.

**CONTINUING DATA**********
VERIFIED THIS APPLN IS A REX OF 05/227,570 02/17/72 PAT 3,779,401

OK JK

**FOREIGN/PCT APPLICATIONS**********
VERIFIED UNITED KINGDOM 4490 02/18/71

OK JK

FOREIGN FILING LICENSE GRANTED 03/10/89

| Foreign priority claimed 35 USC 119 conditions met | Verified and Acknowledged | AS FILED | STATE OR COUNTRY | SHEETS DRWGS. | TOTAL CLAIMS | INDEP. CLAIMS | FILING FEE RECEIVED | ATTORNEY'S DOCKET NO. |
|---|---|---|---|---|---|---|---|---|
| [x] yes [ ] no | [x] yes [ ] no // Examiner's Initials | → | | 0 | 10 | 1 | $1,770.00 | |

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350 JERICHO TURNPIKE
JERICHO, NY 11753

TITLE

PNEUMATIC DEVICE FOR MOVING ARTICLES

U.S. DEPT. of COMM.-Pat. & TM Office — PTO-436L (rev. 10-78)

REQUESTER CORRESPONDENCE ADDRESS: PATENT OWNER [X] THIRD PARTY [ ]

SAME AS ABOVE

| COPENDING OFFICE PROCEEDINGS | | PREPARED FOR CERTIFICATE |
|---|---|---|
| TYPE OF PROCEEDING | NUMBER | A. Tatar 8/25/88 (Docket Clerk) |
| 1 | | REEXAMINED AND PASSED FOR CERTIFICATE |
| 2 | | L. J. Paperner 317 (Primary Examiner) (Group) |
| 3 | | |



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CONTENTS

Entered

REQUEST PAPERS FILED

| | | |
|---|---|---|
| 1 | 4-15-88 | Title Report |
| 2 | 4-13-88 | Notice of Reexam Filing Date |
| 3 | 4-14-88 | Notice of Assigned Group |
| 4 | | REX (2 pgs) May 25, 1988 |
| 5 | 88 | (illegible) (illegible) 25 1988 |
| 6 | | NIRC Aug. 25 1988 |
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SEARCH NOTES

| | Date | Ex'r |
|---|---|---|
| Class 414 (Look) Class 91 (Valerie) | 8/5/88 | |

LITIGATION REVIEW (exmr. init.) 5/17/88 (date)

| CASE NAME | DIRECTOR INITIALS |
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| | |

CLAIM NO. FOR O.G. 9

DRAWING FIG. FOR CERTIFICATE AND FOR O.G. 1

APPLICATION NUMBER 90001477

SERIAL NUMBER 90/001,477

OWNER

APPLICANTS

REEXAMINATION FIELD OF SEARCH

| Class | Sub | Date | Ex'r |
|---|---|---|---|
| 414 | 3 | | |
| | 749 | | |
| | 751 | 8/5/88 | HB |
| 91 | Dig 4 | | |
| 92 | 85R | | |
| | 169 | | |
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| 198 | 619 | | |
| 104 | 154 | | |
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INDEX OF CLAIMS

| Claim Final | Claim Original | Date | Claim Final | Claim Original | Date |
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| | 1 | | 26 | | |
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SYMBOLS

STATUS

√ ..... Rejected
= ..... Patentable
– ..... (Through numeral) Canceled
A ..... Appeal
O ..... Objected
D ..... Disclaimed/Dedicated

63




RECEIVE

MAR 18 1988

APPLICATION BRANCH

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

90001477

Patent: U.S. Pat. No. 3,779,401

Date of Issue: Dec. 18, 1973

Name of Patentee: George Carroll

Title of Invention: Pneumatic Device For Moving Articles

Commissioner of Patents and Trademarks

Box REEXAM

Washington, D.C. 20231

## REEXAMINATION REQUEST

Reexamination is requested pursuant to 37 CFR 1.510 in respect of the above-identified patent.

### PRIOR PATENTS AND PUBLICATIONS

The prior patents and publications which are cited on the attached Form PTO-1449 are attached:

☒ An English translation of the necessary portions and pertinent parts of the non-English prior patents and publications is attached.

### IDENTIFICATION OF CLAIMS FOR WHICH REEXAMINATION IS REQUESTED

The claims of the above identified patent for which reexamination is requested are claims 1-8

### STATEMENT OF NEW QUESTION OF PATENTABILITY

The substantial new question of patentability raised by the above prior art is set forth in the attached STATEMENT OF NEW QUESTIONS OF PATENTABILITY (37 CFR 1.510(b)(1)).

### DETAILED EXPLANATION OF PERTINENCY OF PRIOR ART

☒ The pertinency of the cited prior art to the claims for which reexamination is requested is set forth in the attached DETAILED EXPLANATION OF PERTINENCY OF PRIOR ART (37 CFR 1.510(b)(2)).

☐ The person requesting reexamination is the patent owner and submits that the patent claims distinguish over the cited prior art as set forth in the attached DETAILED EXPLANATION OF PERTINENCY OF PRIOR ART.

☐ The person requesting examination is the patent owner and submits herewith a PROPOSED AMENDMENT in the form of a full copy of the text of:

☐ (1) each claim, and

☐ (2) each paragraph

which is amended in which the matter proposed to be deleted is placed between brackets and matter proposed to be added is underlined.

*NOTE: This can only be done where the patent owner is the requester. 37 CFR 1.510 (e).*

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(Reexamination Request [18-1]—page 1 of 3)

## CUT-UP COPY OF PATENT

Submitted herewith is a cut-up copy of the original patent showing single columns of the patent mounted or reproduced on one side of a separate paper (37 CFR 1.510(b)(4)).

## CONCURRENT OR PRIOR PROCEEDINGS

Also included is a copy of

- ☐ a disclaimer for this patent
- ☐ certificate of correction for this patent
- ☐ reexamination certificate previously issued for this patent

*and/or*

- ☐ concurrently there is pending for this patent proceedings as set forth on the attached STATEMENT OF CONCURRENT PROCEEDINGS.

## REQUEST BEING FILED TO DISSOLVE PENDING INTERFERENCE

- ☐ This reexamination request is being filed as part of a motion under 37 CFR 1.231(a)(1)

## CERTIFICATION OF SERVICE

The signature below certifies that:

- ☐ A copy of this request and all accompanying papers has been served on the patent owner at the address provided for in 37 CFR 1.33(c) by depositing the documents in an envelope bearing first class postage in an official U.S. Postal Service repository at the date set forth below addressed as follows:

  Name _____

  Address _____

  _____

- ☐ Service was not possible and a duplicate copy of all papers is hereby submitted to the Office.

## FEE

- ☒ A check in the amount of $1,770.00 is attached.
- ☐ Please charge my Deposit Account No. _____ in the amount of $1,770.00. A duplicate of this request is attached.

Any refund should be made by

- ☒ check
- ☐ credit to Deposit Account No. _____



## IDENTIFICATION OF PERSON MAKING THIS REQUEST

The name and address of the person making this request is

Name HOFFMANN & BARON

Address 350 Jericho Turnpike

Jericho, New York 11753

Tel. No. ( 516 ) 822-3550

## ADDRESS OF CORRESPONDENCE

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Gerald T. Bodner

Signature

Gerald T. Bodner

*(Type or print name of party signing and title, if applicable)*

*(when attorney signs add)*

Reg. No. 30,449

Tel. No. ( 516 ) 822-3550

- ☐ Patent Owner
- ☐ Third Party Requester
- ☒ Attorney for Patent Owner
- ☐ Attorney for Requester

*NOTE: The attorney must have a power of attorney or be acting in a representative capacity pursuant to 37 CFR 1.34(a). 37 CFR 1.510(f).*

MAR 18 1988

APPLICATION BRANCH

90001477

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent: U.S. Patent No. 3,779,401 Docket No.: 163-5

Date of Issue: December 18, 1973 Dated: March 18, 1988

Name of Patentee: George Carroll

Title of Invention: PNEUMATIC DEVICE FOR MOVING ARTICLES

Commissioner of Patents
and Trademarks
Box REEXAM
Washington, D.C. 20231

STATEMENT ACCOMPANYING REQUEST FOR REEXAMINATION

Sir:

Reexamination under 35 U.S.C. 302-307 and 37 C.F.R. 1.510 is respectfully requested by the patent owner of United States Patent No. 3,779,401, which issued on December 18, 1973 to George Carroll. This patent is still enforceable.

CLAIMS FOR WHICH REEXAMINATION IS REQUESTED

Reexamination is requested of Claims 1 through 8 of the Carroll patent in view of German Gebrauchsmuster No. 19 82 379. The German Gebrauchsmuster is also owned by the same patent owner. The patent owner acquired, by assignment, the Carroll patent for which reexamination is requested after the Carroll patent issued. The German Gebrauchsmuster is listed on attached form PTO-1449, and a copy of the German patent, as well as an English translation of the same, are enclosed.

EXPRESS MAIL CERTIFICATE

Date 3/18/88 Label No B91562722

I hereby certify that, on the date indicated above, I deposited this paper or fee with the U.S. Postal Service & that it was addressed for delivery to the Commissioner of Patents & Trademarks Washington D.C. 20231 by "EXPRESS MAIL Post Office to Addressee" service

Marguerite Franco Marguerite Franco

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EXPLANATION OF PERTINENCY AND MANNER OF APPLYING CITED PRIOR ART TO CLAIMS 1 THROUGH 8, FOR WHICH REEXAMINATION IS REQUESTED

It is believed that the Patent and Trademark Office may consider the German Gebrauchsmuster to raise substantial new questions regarding the patentability of Claim 1 of the Carroll patent, when combined with the other references of record, such as U.S. Patent No. 3,390,580 (Taylor).

Claim 1 of the Carroll patent, the only independent claim, is repeated below:

> 1. A device for moving articles comprising a cylinder of non-ferrous material, a piston including a permanent magnet having a pole-piece on each axial side thereof, a body disposed outside and adjacent to said cylinder, said body including a permanent magnet which substantially surrounds the cylinder, there being a pole piece on each axial side of the permanent magnet included in said body, and means for controlling the admission of pressure fluid into the cylinder and exhaust of fluid from the cylinder for moving the piston in the cylinder, the attractive forces between the permanent magnets being such that movement of the piston causes corresponding movement of the body below a predetermined load on the body and such that above said predetermined load movement of the piston does not cause corresponding movement of the body.

The German patent discloses a device for transporting goods. The device includes a guide cylinder made from a non-magnetic material, a piston which supports an inner magnet and which reciprocatingly slides within the cylinder, and an outer magnet mounted on the outside of the cylinder.

The guide cylinder includes inlets and outlets for receiving and exhausting air or other pressure medium to effect reciprocal movement of the piston within the cylinder. The magnetic attraction between the inner and outer magnets causes the outer magnet to follow the piston in its movement along the cylinder.

## STATEMENT POINTING OUT SUBSTANTIAL NEW QUESTION OF PATENTABILITY

The German patent referred to above is not of record in the prosecution file of the Carroll patent. The Carroll patent was assigned to the present patent owner (which also owns the German patent) after the Carroll patent had issued. It is believed that the Patent and Trademark Office (may) find the German patent, in combination with the other references which were cited during the prosecution of the Carroll patent (a copy of each reference is also enclosed and noted on PTO form 1449), to disclose several of the primary structural features of the device defined by Claim 1. Accordingly, a substantial new question of patentability with respect to Claim 1 may be raised by the additional disclosure of the German patent.

Claims 2 through 8 of the Carroll patent depend directly or indirectly from Claim 1. Because of the materiality of the German patent to the examination of main Claim 1 of the Carroll patent, and because of the dependency of the remaining claims of the Carroll patent on Claim 1, it is urged that a substantial new question of patentability may also exist with respect to depending Claims 2 through 8, and it is respectfully requested that these claims be reexamined along with Claim 1 of the Carroll patent.

Respectfully submitted,

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**United States Patent** [19]
Carroll

[54] PNEUMATIC DEVICE FOR MOVING ARTICLES

[76] Inventor: George Carroll, 12 Palmerston, Stockport, England

[22] Filed: Feb. 17, 1972
[21] Appl. No.: 227,570

[30] Foreign Application Priority Data
Feb. 18, 1971 Great Britain ..... 4,890/71

[52] U.S. Cl. ..... 214/1 BB, 91/DIG. 4, 92/169
[51] Int. Cl. ..... F01b 11/00
[58] Field of Search ..... 214/1 BB, 1 BT; 294/65.5; 91/DIG. 4; 92/169, 170

[56] References Cited
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3,390,580 7/1968 Taylor ..... 92/5 R X

[11] 3,779,401

[45] Dec. 18, 1973

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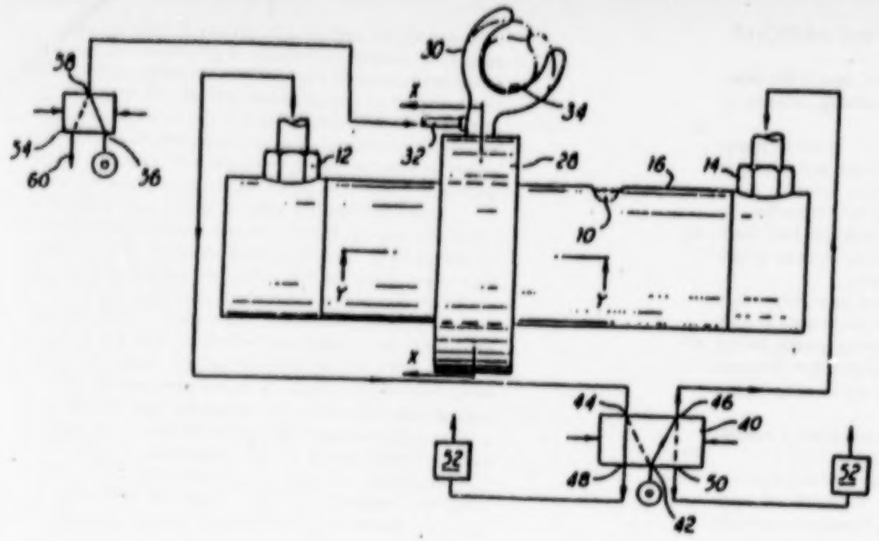
*Primary Examiner*—Gerald M. Forlenza
*Assistant Examiner*—George F. Abraham
*Attorney*—Francis C. Browne et al.

[57] ABSTRACT

A device for moving articles comprising a cylinder of non-ferrous material, a piston including a magnet movable within said cylinder, means for controlling the admission of pressure fluid to the cylinder for moving said piston and a body disposed outside and adjacent to said cylinder, said body including a magnet, the arrangement being such that movement of said piston causes a corresponding movement of said body.

8 Claims, 6 Drawing Figures



# ...UMATIC DEVICE FOR MOVING ARTICLES

This invention relates to a magnetic device for moving articles and in particular for moving articles of clothing.

It has previously been proposed to provide pneumatic devices which include a cylinder and a piston mounted on a piston rod working in said cylinder. Such devices suffer from the disadvantage that considerable space is required to accommodate the piston rod. Such a distance being up to twice the distance through which an article may be moved by the device.

Further, in the clothing industry in particular, very light loads are required to be moved preferably at high speeds or at both high speeds and slower speeds during transfer of an article from one site to another. Devices as previously proposed cannot operate in accordance with these requirements.

The present invention has been made from a consideration of the aforesaid disadvantages.

According to the invention there is provided a device for moving articles comprising a cylinder of non-ferrous material, a piston including a magnet movable within said cylinder, means for controlling the admission of pressure fluid to the cylinder for moving said piston and a body disposed outside and adjacent to said cylinder, said body including a magnet, the arrangement being such that movement of said piston causes a corresponding movement of said body.

In a preferred embodiment of the invention the body comprises an annular magnet surrounding the cylinder having means mounted thereon for holding or supporting an article. Inlets for pressure fluid are preferably provided at each end of the cylinder and the input and/or exhaust of pressure fluid to the cylinder is preferably controlled by a valve. Means may also be provided for adjusting the conditions of pressure fluid within the cylinder so that the piston movement can be halted during travel from one end of the cylinder to the other and/or so that the speed of the piston during travel of the cylinder can be varied.

The pressure fluid employed in the present invention is preferably compressed air so that the device is pneumatic. It is however possible for the pressure fluid to be a liquid so that the device is hydraulic.

The invention is particularly adapted to move light loads such as articles of clothing at high speeds and for this purpose the means for holding or supporting the article is preferably a resilient pneumatically operable gripping device.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 shows the device and associated control means schematically;

FIG. 2 is a section on the line X—X of FIG. 1;

FIG. 3 is a section on the line Y—Y of FIG. 2.

FIG. 4 shows the magnetic field using a single magnet;

FIG. 5 shows the magnetic field where a plurality of magnets are employed; and

FIG. 6 shows the device in plan view.

Referring to the drawings the device comprises a cylinder 10 of non-ferrous material having parts 12 and 14 adjacent each end. A coating 16 of material having a low coefficient of friction, such as polytetrafluoromethylene, is formed on both outer and inner surfaces





...id cylinder. A piston 18 is located in the cylinder, the piston comprising a cylindrical permanent magnet 20, having a diameter less than the internal diameter of the cylinder 10, clamped between two non-ferrous piston end members 22, of substantially cylindrical shape but of overall diameter less than the internal diameter of the cylinder. The magnet 20 and piston end members are held together by means of a bolt 21 passing through a bore in the magnet and end members.

Each end member has an annular groove 24 thereround which accommodates a resilient sealing ring 26 adapted to engage the inner wall of the cylinder and form a fluid tight seal. Cushions of resilient material are fixed to each end member, or as shown in FIG. 2 to the head of the bolt 21 to prevent damage to the device when the piston reaches the ends of the cylinder.

A permanent magnet 28 of annular shape surrounds the cylinder with minimum clearance, the polarisation of magnets 20 and 28 being such that movement of the piston, and hence magnet 20 within the cylinder causes corresponding movement of magnet 28 outside the cylinder (see FIG.4). piston, and hence magnet 20 within the cylinder causes corresponding movement of magnet 28 outside the cylinder (see FIG.4).

A pneumatically operable article gripping device 30 is mounted on magnet 28. The gripper device 30 comprises a hollow substantially U-shaped body of resilient material, such as rubber, having an inlet 32 for pressure fluid. The U-shaped body is held in shape by means of light porous reinforcing material therewithin. A strip of material 34 is bonded to the body between the arms thereof, said material being material of less elasticity than that of the body so that when pressure fluid is admitted through inlet 32 the arms of the U-shaped body will bend inwards towards each other (as shown in dotted lines in FIG.1) and will grip any article therebetween. In order to prevent the magnet 28 rotating relative to the cylinder a guide rod 36 (FIG.6) is mounted outside the cylinder and axially parallel thereto, a tie bar 38 being fixed to the magnet and having a hole bore therein which runs freely on the guide rod.

The device is controllable by means of a five part spool valve 40 which has a port 42 connected to a supply of compressed air (not shown), port 44 connected to cylinder port 12, port 46 connected to cylinder port 14 and exhaust ports 48 and 50. As shown in FIG. 1 the spool valve is in position to supply compressed air to cylinder port 14 and cylinder port 12 is connected to exhaust port 48 so that the piston, and with it magnet 28 and gripping device 30, is moved to the left (as viewed in the drawing). On reversing the spool valve compressed air will be supplied to cylinder port 12 and cylinder port 14 will be connected to exhaust port 50 so that the piston moves towards the right. The exhaust ports of valve 40 are preferably connected to variable restrictor mechanisms 52 which are automatically operable to control the exhaust from the valve 40 and hence the speed of the piston in the cylinder.

The supply and exhaust of pressure air to the gripping device 30 is controlled by a spool valve 54 having a port 56 connected to a compressed air supply (not shown), a port 58 connected to inlet 32 and an exhaust port 60. The movement of the magnet 28 along the cylinder can be used to generate signals for operating the valve 54 and if desired the restrictor mechanisms 52 and valve 40.

As illustrated in FIG. 5 more than one magnet may

...vided on the piston and/or around the cylinder. ...t, however, preferred to arrange that the magnetic ...ce between the magnets should not be greatly in excess of that required to move the articles required to be transported. Thus should magnet 28 be obstructed by a person or by some object the piston can still move to the end of the cylinder without any damage to the device and without injury to the person or object.

The device according to the invention is capable of high speed operation, the speed of travel of the piston in the cylinder being a function of the volume of air admitted through the inlet port and exhausted through the exhaust port, this itself being a function of the size of the ports. By appropriate dimensioning of the ports it has been possible without difficulty to move a piston from one end of a 20 foot cylinder to the other end thereof in about 7 seconds.

The device may be used not only for the transfer of articles of clothing, but may be used to carry any article from one site to another along a predetermined path. Thus while the specific embodiment describes an arrangement suitable for transferring an article along a linear path, it is possible to shape the guide rod for example in the form of a helix so that the body will follow a helical path.

In the embodiment described with reference to the drawings a polytetra fluoroethylene coating is applied to the outer surface of the cylinder to provide a low friction surface upon which the body may run. As an alternative it is possible to provide an air bearing between the body and the cylinder. Further it is possible to use the repulsive force of magnets located in longitudinal grooves in the surface of the cylinder and further magnets disposed in the body which maintain the body spaced - apart from said cylinder.

If the device is designed for operation at high speeds, it may be found that the piston is decelerated too abruptly on reaching the end of the cylinder. Better control over deceleration of the piston may be accomplished by coupling the port which is exhausting to a chamber or cylinder containing a non-compressible fluid such as water.

The operation of the device may be triggered by any suitable means such as a timing device and/or a device





...nsitive to the presence, at one end of the device, of an article to be transferred thereby.

What is claimed is:

1. A device for moving articles comprising a cylinder of non-ferrous material, a piston including a permanent magnet having a pole-piece on each axial side thereof, a body disposed outside and adjacent to said cylinder, said body including a permanent magnet which substantially surrounds the cylinder, there being a pole piece on each axial side of the permanent magnet included in said body, and means for controlling the admission of pressure fluid into the cylinder and exhaust of fluid from the cylinder for moving the piston in the cylinder, the attractive forces between the permanent magnets being such that movement of the piston causes corresponding movement of the body below a predetermined load on the body and such that above said predetermined load movement of the piston does not cause corresponding movement of the body.

2. A device as claimed in claim 1, wherein the body comprises an annular magnet surrounding the cylinder ~~and means for holding or supporting an article.~~

3. A device as claimed in claim 2, wherein the means in said body for holding an article comprises a pneumatically operable gripping means.

4. A device as claimed in claim 3, wherein at least a part of the gripping means is adapted to grip an article and is made of resilient material.

5. A device as claimed in claim 1, wherein a port is provided at each end of the cylinder for the input of pressure fluid to, and exhaust of pressure fluid, from the cylinder.

6. A device as claimed in claim 5, wherein a valve is provided for controlling the input of pressure fluid and the exhaust of pressure fluid from the cylinder to thereby control the movement of the piston in the cylinder.

7. A device as claimed in claim 1 in which said body including the permanent magnet surrounds the cylinder.

8. A device as claimed in claim 1 in which the piston includes a plurality of permanent magnets.

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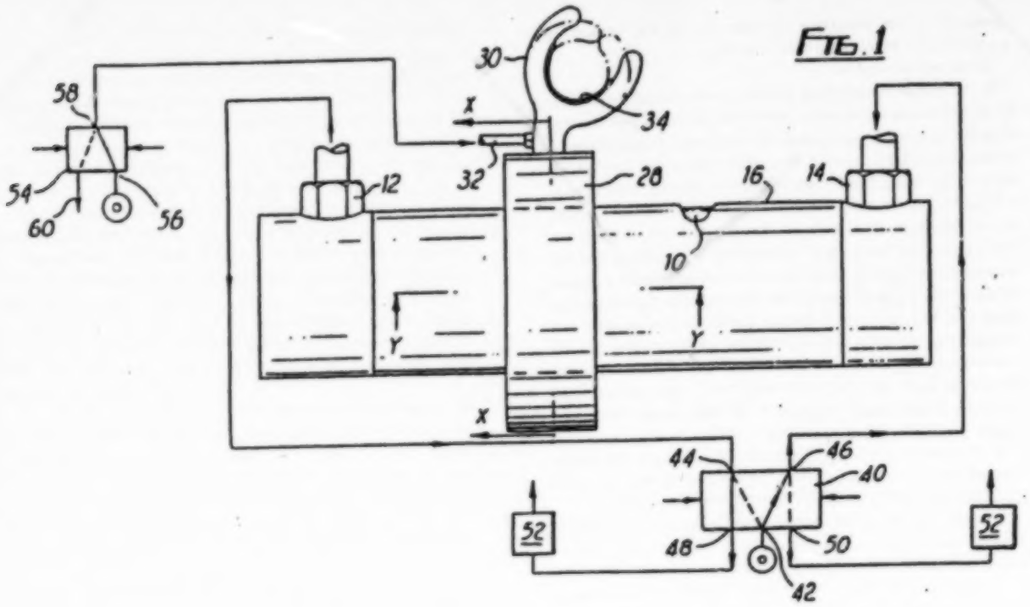
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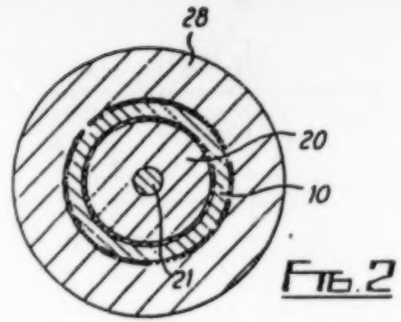
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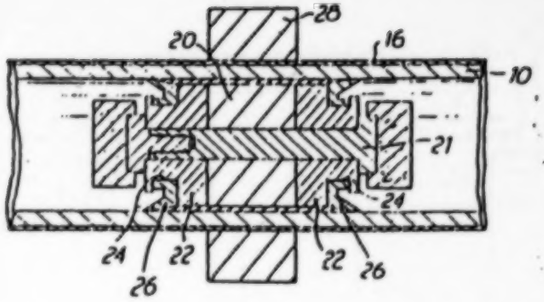


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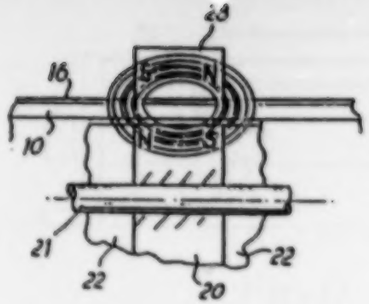


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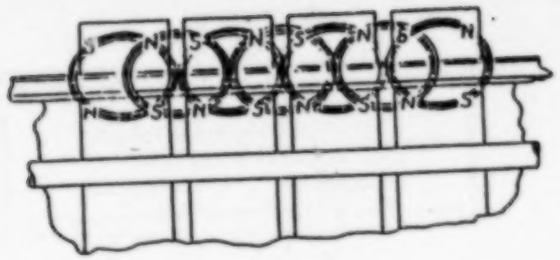

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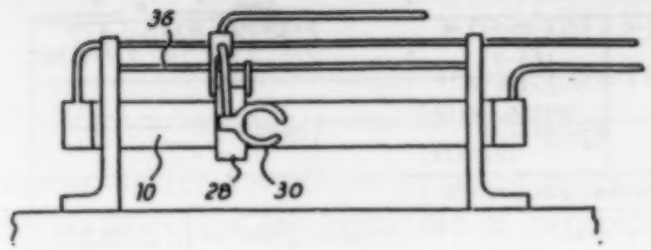


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Sheet 1 of 1

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

ATTY. DOCKET NO. 163-5

SERIAL NO. 40/001,477
U.S. Pat. No. 3,779,401

APPLICANT George Carroll

ISSUE DATE 12/18/73

GROUP 317

# INFORMATION DISCLOSURE CITATION

*(Use several sheets if necessary)*

## U.S. PATENT DOCUMENTS

| EXAMINER INITIAL | | DOCUMENT NUMBER | DATE | NAME | CLASS | SUBCLASS | FILING DATE IF APPROPRIATE |
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Dipl.-Ing.Kurt Stoll,Esslingen a.N.

# FEEDING DEVICE FOR TRANSPORTING OF GOODS TO BE TRANSPORTED BETWEEN AN INITIAL POSITION AND GIVEN END OR INTERMEDIARY POSITIONS

The invention relates to a feeding device for transporting of goods to be transported between an initial position and given end or intermediary position being driven with the aid of a pressure medium as the movement generator,for example,a pneumatic or hydraulic medium.

Devices of the type in question are used,for example,as as hoisting like stroke devices,suspended four post like transport devices etc.

The known devices of the aforementioned type have a complicated structure in combination with large manufacturing costs and require a relatively large space requirement at the place of installation. Among others,and for this reason the use of these known devices is rather limited. It is therefore an object of the invention to overcome these disadvantages.

With respect to the aforementioned purpose the new feeding device in accordance with the invention is provided with a reciprocally movable piston without a piston rod in a tube or a pressure or operating cylinder between the initial position and the end position having the effect of a pressure medium and a reciprocally movable holding device for the goods to be transported being mounted outside of the tube or the pressure or operating cylinder being in a magnetic force connection and oerating connection with the piston. The new device may contain,for example,a reciprocally movable piston which moves under the effect of the pressure medium,a guide tube containing the piston acting as a pressure or operating cylinder made from a nonmagnetic material with inlets and outlets for the pressure medium,an inner magnet which is connected with the piston and guided along the inner wall,an outer magnet on the outer wall of the guide

being reciprocally movable at the area of the inner magnet and may also contain a reciprocally movable holding device for the goods to be transported at the outer magnet. The device in accordance with the invention,which is characterized by a very simple structure,enable to cut the space requirement to practically half of the space requirement with respect to known devices. For example,in hoisting like devices,stroke operated tables etc.,there is only a structural length required which corresponds to the stroke length ,while in the known comparable devices the installation length is about double of the length of the stroke length,so that customarily in such cases one buries the drive cylinder into the ground. The application range of pneumatic or hydraulic operating cylinders in cases of the type in question are substantially expanded with the inventive device,since one can now operate with overlong piston rods,for example,of 10 meters and more,without being afraid to cause instability, while with the known devices a piston rod length of maximal 2 - 3 metters are possible. The holding device of the inventive device is also movable around curves,whereby the guiding is simple,while with suspended feeding devices a lateral friction is caused in the case of curves by the rigid element.

Exemplified embodiments of the subject matter of the invention are illustrated in the drawing. The drawing shows:

Fig.1 a first embodiment of the subject matter of the invention in a side view in a partial illustration in a vertical section,
Fig.2 the device in accordance with Fig.1 in a section along line II-II of Fig.1,
Fig.3 the device in accordance with Fig.1 in a section in accordance with line III-III of Fig.1,
Fig.4a a modified embodiment of the subject matter of the invention in a mode of illustration corresponding to the one of Fig.2,
Fig.4b the device in accordance with Fig.4a,in a side view,
Fig.5 a modified embodiment of the subject matter of the invention in a mode of illustration corresponding to the one of Fig.3,





riation of the subject matter of the invention in a
llustration in a vertical section,
ication of the subject matter of the invention in a plan
n a schematic illustration and
variation of the device in accordance with Fig.7,also in a plan
view in a schematic illustration.

The device in accordance with the invention contains as its most important parts a piston 1 which is reciprocally movable in accordance with arrow 2 under the effect of a pressure medium,air pressure of liquid pressure,and a guide tube 3 cotaining the piston and guiding the same in the manner of a pressure or operating cylinder and which also contains inlets and outlets,not particularly illustrated,for the pressure medium. Moreover,the device in accordance with the invention also contains an inner magnet 4 which is rigidly connected with the piston and which is fed free of contact on the inside along the inner wall of the tube,as well as an outer magnet 5 which is fed contact free from the outside along the outer wall of the tube and between it and the piston is movable along the guide tube thanks to the magnetic force connection.A reciprocally movable holding device 6 for the goods to be transported is provided with the outer magnet being fed with a rolling friction on the guiding tube,for example.

In the embodiment in accordance with Fig.1 to 3 the piston 1 consists of a core 1a, which may be made,for example,from a nonmagnetic material like synthetic material and of packing rings 1b,1c which engage with their outer face or cirfumferential face on the inner tube wall and which act for a tight sealing of space 7 from space 8 within the guiding tube 3. The piston supports an inner magnet 4 which in this case is shaped as a magnetic ring. However,the inner magnet may also be shaped as a magnetic as a molded body,as is illustrated at 9 in Fig.4a,for example. In this latter case the piston is mounted on the inner wall of the guide tube with the assistance of a plurality of guide rollers,for example,three guide rollers 10a,10b,10c,whose rotational axis 11a,11b,11c extend transversely to the longitudinal axis and at an angle with respect to each other and which

their circumferences on the inner wall of the tube.These guide 10a,10b,10c are rotatably mounted on piston 12 in such a manner that that their longitudinal center planes are extend star like with respect to each other (Fig.4a) and form an angle of 120° with respect to each other,whereby their rotational axis are not contained in a single common plane (Fig.4b). In the device in accordance with Figs.1 to 3 the longitudinal prismatic shaped molded body of the piston is provided with one each flexible sealing ring 1b,1c made from rubber or synthetic material in the area of its both axial ends which with its outer circumference engages on the inner wall of the tube. The piston supports between its ends annular shaped inner magnets 4.

In the device in accordance with Figs.1 to 3,the outer magnet 5 is shaped as a magnetic molded body,whose active face 5a facing the guide tube 3 is correspondingly shaped with the associated segment of the tube circumference and is thereby curved toward the inside of the magnet or is cut out in a segment like manner. Such a structure of the outer magnet can also be seen in the magnets 13 of the device in accordance with Figs. 4a,4b. However,the outer magnet may also be shaped as the guiding tube as a ring extending in a coaxial arrangement. It could also be shaped as a not completely closed ring,as is illustrated at 14 which extends only 3/4 of the circumference of guide tube 15,for example.In accordance with Fig.6 the outer magnet may also be shaped as a completely closed ring 16 which completely encompasses the guide tube 17. While in the device in accordance with Fig.5 a space is provided for jolding devices of the guide tube within the movement path of the magnet,see for example,the holding devices 16 in Fig.5 or the holding device 19 in Fig.3,the device in accordance with Fig.6 is thought for cases wherein the guide tube,which extends only over a short axial length,is held at its both ends,whereby the transport movement occurs between these two ends,so that the holding devices do not interfere with the movement of the outer magnet 16. In the devices in accordance with Figs 5 and 6 the inner magnet is also shaped as a completely closed ring 20 or 21





device in accordance with Figs.1 to 3 the holding device 6 a molded body movably guided on the guide tube 3,whose area supports the outer magnet 5 which is connected with the load receiving. In this case the load acts in accordance with arrow 22. This holding device 6 is mounted on the guide tube with the assistance of two rollers 23a,23b which are rotatable and which support with their profiled outer circumference on guide tube 3. In the device in accordance with Fig.5 the mounting of such guide rollers as a supporting element is not required,since the inner ring and the outer ring are coaxially mounted into one another and are thereby mounted self centering in such a manner that the inner air slot is approximately even at all sides. Therefore,no friction occurs during the movement,for example,For this purpose rollers 24a,24b or the roller pairs which contain rollers 24a, 24b are provided which are not supporting rollers as is the case in the embodiment of Fig.1 to 3,but are only support rollers for the load. THis device,wherein the guide tube is a guide element,on the one hand,and as a supporting element,on the other hand,and also coacts during the drive is characterized in that a substantially largermagnetic force can be applied. The new system could also operate in the vertical direction

The support and guide tube advantageously consists of a synthetic material or of brass,for example,which is a nonmagnetic material. One can also form the inner and/or outer magnets as permanent magnets,however,one could also form them as electromagnets with an adjustable power. Finally,one could make the inner and/or outer magnets of only one permanent magnetic part and one total or partial electromagnetic part which can be switched on and switched off arbitrarily. This last modification of the subject matter of the invention permits the possibility to adjust the magnetic power to the given requirements.

The support and guide tube may extend in a straight line in accordance with Fig.7 in such a manner that the path of movement of the holding device for the goods to be transported extends in a straight direction in accordance with arrow 25 (Fig.7) between the initial position A and the end position B. However,the movement path may also be curved. IN the

It can have the form of a circle or an ellipse in accordance with the device in Fig.8, in such a manner thatthe holding device for the goods to be fed may move along an endless path along the ellipsoidal sjaped support and feeding tube 26.





## CLAIMS

1. A feeding device for transporting of the goods to be transported between an initial position and given end or intermediary positions driven by the assistance of a pressure medium acting as the movement generator, for example, a pneumatic or hydraulic medium, characterized in that it is provided with a piston without a piston rod reciprocally fed in a tube or pressure or operating cylinder between the initial position and the end position and a holding device which is reciprocally moved with the piston in a magnetic power and operating connection outside of the tube or the pressure oroperating cylinder.

2. Feeding device in accordance with claim 1, characterized in that it contains a reciprocally moving piston which moves under the effect of the pressure medium and a guiding tube containing the piston and guiding the same in the manner of a pressure or operating cylinder made of a nonmagnetic material with inlets and outlets for the pressure medium, an inner magnet which is fixedly connected with the piston and guided inside of the inner tube wall in a contactless manner, a reciprocally moved outer magnet is fed on the outer wall of the guide tube at the area corresponding to the inner magnet and also contains a reciprocally movable holding device for the goods to be transported being movable together with the outer magnet.

3. Feeding device in accordance with claim 1 or 2, characterized in that the inner magnet is shaped as a magnetic ring.

4. Feeding device in accordance with claim 1 or 2, characterized in that the the inner magnet is shaped as a magnetic molded body.

5. Feeding device in accordance with one of claims 1 to 4, characterized in that the outer magnet is shaped as a magnetic molded body, whose active face which faces the guide tube is formed in accordance with the associated segment of the tube circumference, for example, is curved toward the inside of the magnet or is cut out segment like.

eeding device in accordance with one of claims 1 to 4,characterized in that the outer magnet is shaped as a magnetic ring which extends in a coaxial position around the guide tube in a not completely closed circumferance,for example,only about 3/4 of the circumference of the guide tube.

7. Feeding device in accordance with one of the claims 1 to 4,characterized in that the outer magnet is formed as a completely closed ring totally encompassing the guide tube in a coaxial arrangement.

8. Feeding device in accordance with one of claims 1 to 7,characterized in that the piston supports in its center area the inner magnet and is also movably mounted on the inner wall of the guide tube with the assistance of a plurality of three guide rollers,for example, whose rotating axis are mounted transversely to the longitudinal transverse axis,on the one hand,and extend in an angle with respect to each other,on the other hand,and which support with their circumferences on the inner tube wall.

9. Feeding device in accordance with claim 8,characterized in that that three guide rollers are rotatably mounted on the piston,whose longitudinal center planes extend star like with respect to each other and form one each angle of 120° with respect to each other, whereby advantageously their rotating axis are not contained in a single common plane with respect to each other.

10. Feeding device in accordance with claims 8 or 9,characterized in that the advantageous longitudinally prismatic piston supports one each packing ring in the areas of its front and rear axial end which with its outer circumferential face engages the inner tube wall.





Feeding device in accordance with one of claims 1 to 7,characterized in that the advantageously longitudinally prismatic molded body of the piston is provided at the area of its both axial ends with or each packing ring which with its outer circumference engages the inner wall of the tube being made from rubber or syynthetic material for example,and which supports between its ends the ring like shaped inner magnet.

12. Feeding device in accordance with claims 1 to 11,characterized in that the holding device is guided on the guide tube with a rolling friction.

13. Feeding device in accordance with claim 12,characterized in that the holding device is shaped as a molded body which is movably fed on the guide tube with the assistance of rotatably mounted guide rollers or guide roller pairs in the area of its front and rear end, whose center area supports the outer magnet and is connected with the laod receiving.

14. Feeding device in accordance with one of claims 1 to 11,characterize in that the holding devices are fed without guide rollers on the guide tube alone under the influence of the developed magnetic power flow.

15. Feeding device in accordance with claims 1 to 14,characterized in that the inner and/or outer magnet are shaped as a permanent magnet.

16. Feeding device in accordance with one of claims 1 to 14,characterize in that the inner and/or outer magnet is shaped as an electromagnet with adjustable power.

17. Feeding device in accordance with one of claims 1 to 14,characterize in that the inner and/or outer magnet consists of a permanent magnet part and of a partially electromagnetic part which can be switched o and off arbitrarily

mit dem Kolben fest verbundenen und innen entlang der Rohrinnenwandung berührungsfrei geführten Innenmagneten, einen außen an der Außenwandung des Führungsrohres entlang in deren den Innenmagneten entsprechenden Bereich hin und her beweglich geführten Außenmagneten und eine zusammen mit den Außenmagneten hin und her bewegliche Halterung für das Fördergut enthalten. Die erfindungsgemäße Anordnung, die sich durch einen denkbar einfachen Aufbau auszeichnet, macht es möglich, den Raumaufwand auf praktisch die Hälfte des Aufwandes bei bekannten Anordnungen herabzusetzen. So z.B. ist bei aufzugartigen Vorrichtungen, Kuttschen usw. nur noch eine der Hublänge entsprechende Einbaulänge erforderlich, während bei den bekannten vergleichbaren Anordnungen die Einbaulänge etwa doppelt so groß wie die Hublänge ist, weswegen man in diesen Fällen manchmal den Antriebszylinder in den Boden eingräbt. Mit der erfindungsgemäßen Anordnung wird der Anwendungsbereich von pneumatischen oder hydraulischen Arbeitszylindern in Fällen der hier in Frage stehenden Art wesentlich erweitert, da man nunmehr mit überlangen Kolbenstangen, z.B. von 10 m und mehr arbeiten kann, ohne Instabilität zu befürchten, während bei bekannten Anordnungen eine Kolbenstangenlänge von maximal 2 - 3 m möglich ist. Die Halterung der erfindungsgemäßen Anordnung ist auch um Kurven bewegbar, wobei die Führung einfach ist, während bei Hängeförderern im Falle von Kurven eine seitliche Reibung des ziehenden Elementes auftritt.

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In der Zeichnung sind Ausführungsbeispiele des Gegenstandes der Erfindung dargestellt. Es zeigen:

Fig. 1 eine erste Ausführungsform des Gegenstandes der Erfindung in einer Seitenansicht in Teildarstellung in einem senkrechten Schnitt,

Fig. 2 die Anordnung nach Fig. 1 in einem Schnitt gemäß der Linie II-II der Fig. 1,

Fig. 3 die Anordnung nach Fig. 1 in einem Schnitt gemäß der Linie III-III der Fig. 1,

Fig. 4 a eine abgewandelte Ausführungsform des Gegenstandes der Erfindung in einer Darstellungsweise entsprechend derjenigen nach Fig. 2,

Fig. 4 b die Anordnung nach Fig. 4 a in einer Seitenansicht,

Fig. 5 eine abgewandelte Ausführungsform des Gegenstandes der Erfindung in einer Darstellungsweise entsprechend derjenigen nach Fig. 3,

Fig. 6 eine weitere Variante des Erfindungsgegenstandes in Teildarstellung in einem senkrechten Schnitt,

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PATENTANWALT
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# Fördervorrichtung zum Transportieren des Fördergutes zwischen einer Ausgangsstellung und gegebenen End- oder Zwischenstellungen

Die Erfindung betrifft eine mit Hilfe eines Druckmediums als Bewegungserzeuger, z. B. eines pneumatischen oder hydraulischen Mediums betriebene Fördervorrichtung zum Transportieren des Fördergutes zwischen einer Ausgangsstellung und gegebenen End- oder Zwischenstellungen.

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Anordnungen der hier in Frage stehenden Art werden z. B. als aufzugartige Hubvorrichtungen, hängefördrern, rollenpostartige Transportvorrichtungen usw. verwendet.

Die bekannten Anordnungen der vorgenannten Art haben einen komplizierten, mit großen Herstellungskosten verbundenen Aufbau und machen darüber hinaus einen relativ großen Aufwand an Einbauraum erforderlich. U.a. auch aus diesem Grunde ist die Anwendung dieser bekannten Anordnungen beschränkt. Das Ziel der Erfindung besteht darin, hier Abhilfe zu schaffen.

Zu dem oben genannten Zweck besitzt gemäß der Erfindung die neue Fördervorrichtung einen in einem Rohr oder Druck- oder Arbeitszylinder zwischen der Ausgangsstellung und der Endstellung unter Wirkung des Druckmediums hin und her beweglich geführten Kolbenstangenlosen Kolben und eine außerhalb des Rohres oder Druck- oder Arbeitszylinders geführte, mit den Kolben in magnetischer Kraft- und Wirkverbindung stehende und hierbei mit diesem hin und her bewegliche Halterung für das Fördergut. Die neue Vorrichtung kann hierbei z. B. einen unter Einwirkung des Druckmediums hin und her beweglichen Kolben, ein den Kolben enthaltendes und führendes und hierbei in der Art eines Druck- oder Arbeitszylinders wirkendes Führungsrohr aus nichtmagnetischem Material mit Ein- und Auslassen für das Druckmedium, einen

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mit seinem Außenumfang an der Rohrinnenwand anliegt. Der Kolben trägt zwischen seinen Enden den ringartig ausgebildeten Innenmagneten 4.

Bei der Anordnung nach Fig. 1 bis 3 ist der Außenmagnet 5 als magnetisches Formstück ausgebildet, dessen dem Führungsrohr 3 zugewandte wirksame Fläche 5 a den zugeordneten Abschnitt des Rohrumfangs entsprechend ausgebildet und hierbei nach den Magnetinneren gewölbt oder segmentartig ausgeschnitten ist. Eine solche Ausbildung des Aussenmagneten ist auch bei den Magneten 13 der Anordnung nach Fig. 4 a, 4b gezeigt. Der Außenmagnet kann jedoch auch als das Führungsrohr in koaxialer Anordnung umgebender Ring ausgebildet sein. So kann er als ein nicht völlig geschlossener Ring ausgebildet sein, wie er bei 14 dargestellt ist, der sich z.B. nur über 3/4 des Umfangs des Führungsrohres 15 erstreckt. Gemäß Fig. 6 kann der Außenmagnet auch als völlig geschlossener Ring 16 ausgebildet sein, der das Führungsrohr 17 ganz umschließt. Während bei der Anordnung nach Fig. 5 Platz für Halterungen des Führungsrohres innerhalb der Bewegungsbahn des Magneten vorhanden ist, vgl. z.B. die Halterungen 18 in Fig. 5 oder die Halterung 19 in Fig. 3, ist die Anordnung gemäß Fig. 6 für Fälle gedacht, bei denen das Führungsrohr, das sich nur über eine kurze axiale Länge erstreckt, an seinen beiden Enden gehaltert ist, wobei die Transportbewegung zwischen diesen beiden Enden stattfindet, so daß die Halterungen die





Bewegung des Außenmagneten 16 in keiner Weise stören. Bei den Anordnungen nach Fig. 5 und 6 ist im übrigen der Innenmagnet ebenfalls als völlig geschlossener Ring 20 bzw. 21 ausgebildet.

Bei der Anordnung nach Fig. 1 bis 3 ist die Halterung 6 als an Führungsrohr 3 verschieblich geführtes Formstück ausgebildet, dessen mittlerer Bereich den Außenmagneten 5 trägt und das mit der Lastaufnahme verbunden ist. Die Last wirkt in diesem Falle gemäß Pfeil 22. Diese Halterung 6 ist an Führungsrohr mit Hilfe von zwei Rollen 23a, 23b gelagert, die drehbar sind und sich mit ihren profilierten Außenumfang an Führungsrohr 3 abstützen. Bei der Anordnung nach Fig. 5 hingegen ist das Anbringen von solchen Führungsrollen als tragendes Element nicht erforderlich, da der Innenring und der Außenring koaxial ineinander gelagert und somit selbstzentrierend angeordnet sind, derart, daß der Luftspalt zwischen ihnen an allen Seiten annähernd gleich ist. Es findet z.B. somit keine Reibung während der Bewegung statt. Aus diesem Grunde dienen die Rollen 24a, 24b bzw. die Rollenpaare, die jeweils Rollen 24a, 24b enthalten, nicht als Abstützrollen, wie bei der Ausführungsform nach Fig. 1 bis 3, sondern nur noch als Tragrollen für die Last. Diese Anordnung, bei der das Führungsrohr 15 einerseits als Führungselement und andererseits als tragendes Element wirkt und darüber hinaus beim Antrieb mitwirkt, zeichnet sich da-





Fig. 7 eine Abwandlung des Gegenstandes der Erfindung in einer Draufsicht in schematischer Darstellung und

Fig. 8, eine Variante zu der Anordnung nach Fig. 7 ebenfalls in einer Draufsicht in schematischer Darstellung.

Die erfindungsgemäße Anordnung enthält als wichtigste Teile einen Kolben 1, der unter Einwirkung des Druckmediums - Druckluft oder Druckflüssigkeit - gemäß Pfeil 2 hin und her beweglich ist, und ein Führungsrohr 3, das den Kolben enthält und führt und hierbei in der Art eines Druck- oder Arbeitszylinders wirkt und das demzufolge nicht weiter dargestellte Einlässe und Auslässe für das Druckmedium besitzt. Außerdem enthält die erfindungsgemäße Vorrichtung einen Innenmagneten 4, der mit dem Kolben fest verbunden ist und von innen her an der Rohrinnenwandung entlang berührungsfrei geführt ist, sowie einen Aussenmagneten 5, der von außen her an der Rohraußenwandung entlang berührungsfrei geführt ist und dank der magnetischen Kraftverbindung zwischen ihm und den Kolben mit diesem am Führungsrohr entlang beweglich ist. Mit dem Aussenmagneten ist eine mit ihm hin und her bewegliche Halterung 6 für das Fördergut vorgesehen, die am Führungsrohr z. B. unter rollender Reibung geführt ist.





Bei der Ausführungsform nach Fig. 1 bis 3 besteht der Kolben 1 aus einem Kern 1a, der z. B. aus nichtmagnetischem Material, z.B. Kunststoff hergestellt werden kann, und aus Dichtungsringen 1b, 1c, die mit ihrer Aussenfläche oder Umfläche an der Rohrinnenwand anliegen und zum dichten Abschließen des Raumes 7 von Raum 8 innerhalb des Führungsrohres 3 dienen. Der Kolben trägt einen Innenmagneten 4, der in diesem Falle als Magnetring ausgebildet ist. Der Innenmagnet kann jedoch auch als magnetisches Formstück ausgebildet sein, wie z.B. bei 9 in Fig. 4a gezeigt ist. In diesem letzteren Falle ist der Kolben an der Innenwand des Führungsrohres mit Hilfe von mehreren Führungsrollen, z.B. drei Führungsrollen 10a, 10b, 10c gelagert, deren Drehachsen 11a, 11b, 11c quer zur Rohrlängsachse und unter einem Winkel zueinander verlaufen und die sich mit ihren Umfang an der Rohrinnenwand abstützen. Diese Führungsrollen 10a, 10b, 10c sind am Kolben 12 so drehbar gelagert, daß ihre Längsmittelebenen sternartig zueinander verlaufen (Fig. 4 a ) und hierbei jeweils einen Winkel von 120° miteinander bilden, wobei ihre Drehachsen nicht in einer einzigen gemeinsamen Ebene enthalten sind (Fig. 4 b). Bei der Anordnung nach Fig. 1 bis 3 hingegen ist der als kurzer prismatischer Formstück ausgebildete Kolben in Bereich einer beiden axialen Enden jeweils mit einen elastischen Dichtungsring 1b, 1c aus Gummi oder Kunststoffmaterial versehen, der



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Führungsrohres erstreckender magnetischer Ring ausgebildet ist.

7. Fördervorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Außenmagnet als das Führungsrohr in koaxialer Anordnung umschließender, völlig geschlossener Ring ausgebildet ist.

8. Fördervorrichtung nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß der Kolben in seinem mittleren Bereich den Innenmagneten trägt und im übrigen an der Innenwand des Führungsrohres mit Hilfe von mehreren, z.B. drei Führungsrollen verfahrbar gelagert ist, deren Drehachsen einerseits etwa quer zur Kolbenlängsachse und andererseits unter einem Winkel zueinander verlaufen und die sich mit ihrem Umfang an der Rohrinnenwand abstützen.

9. Fördervorrichtung nach Anspruch 8, dadurch gekennzeichnet, daß am Kolben drei Führungsrollen drehbar gelagert sind, deren Längsmittelebenen sternartig zueinander verlaufen und hierbei jeweils einen Winkel von 120° miteinander bilden, wobei zweckmäßig ihre Drehachsen nicht in einer einzigen gemeinsamen Ebene enthalten sind.

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Rohrinnenwandung berührungsfrei geführten Innenmagneten, einen außen an der Außenwandung des Führungsrohres entlang in deren den Innenmagneten entsprechenden Bereich hin und her beweglich geführten Außenmagneten und eine zusammen mit den Außenmagneten hin und her bewegliche Halterung für das Fördergut enthält.

3. Fördervorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Innenmagnet als Magnetring ausgebildet ist.

4. Fördervorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Innenmagnet als magnetisches Formstück ausgebildet ist.

5. Fördervorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Außenmagnet als magnetisches Formstück ausgebildet ist, dessen dem Führungsrohr zugewandte wirksame Fläche dem zugeordneten Abschnitt des Rohrumfangs entsprechend ausgebildet, z.B. nach dem Magnetisieren so gewölbt oder segmentartig ausgeschnitten ist.

6. Fördervorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Außenmagnet als ein das Führungsrohr in koaxialer Anordnung umgebender, nicht völlig geschlossener, sich z.B. nur über 3/4 des Umfangs des

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durch aus, daß eine wesentlich größere magnetische Kraft aufgewendet werden kann. Das neue System könnte im übrigen auch in umgekehrter Richtung arbeiten.

Das Trag- und Führungsrohr besteht zweckmäßigerweise aus Kunststoffmaterial oder z.B. auch aus Messing, also insgesamt aus einem nicht magnetischen Werkstoff.

Man kann die Innen- und/oder Außenmagnete als Permanentmagnete ausführen, man kann sie jedoch auch als Elektromagnete einstellbarer Stärke ausbilden. Schließlich kann man die Innen- und/oder Außenmagnete auch aus einer permanentmagnetischen Partie und einer ganz oder teilweise beliebig an- und abschaltbaren elektromagnetischen Partie herstellen. Diese letztere Variante des Erfindungsgegenstandes gibt die Möglichkeit, die magnetische Kraft den jeweiligen Erfordernissen anzupassen.

Das Trag- und Führungsrohr kann gemäß Fig. 7 geradlinig verlaufen, derart, daß die Bewegungsbahn der Halterung für das Fördergut zwischen der Ausgangsstellung A und der Endstellung B in gerader Richtung gemäß Pfeil 25 verläuft (Fig. 7). Die Bewegungsbahn kann jedoch auch gekrümmt sein. Im Extremfall kann sie gemäß der Anordnung nach Fig. 8 die Form eines Kreises oder einer Ellipse haben, derart, daß die Halterung für das Fördergut sich entlang des ellipsenartig geformten Trag- und Führungsrohr 26, also entlang einer endlosen Bahn bewegen kann.

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## Ansprüche

1. Mit Hilfe eines Druckmediums als Bewegungserzeuger, z.B. eines pneumatischen oder hydraulischen Mediums, betriebene Fördervorrichtung zum Transportieren des Fördergutes zwischen einer Ausgangsstellung und gegebenen End- oder Zwischenstellungen, dadurch gekennzeichnet, daß sie einen in einem Rohr oder Druck- oder Arbeitszylinder zwischen der Ausgangsstellung und der Endstellung hin und her beweglich geführten kolbenstangenlosen Kolben und eine außerhalb des Rohres oder Druck- oder Arbeitszylinders geführte, mit dem Kolben in magnetischer Kraft- und Wirkverbindung stehende und hierbei mit diesem hin und her bewegliche Halterung für das Fördergut besitzt.

2. Fördervorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß sie einen unter Einwirkung des Druckmediums hin und her beweglichen Kolben, ein den Kolben enthaltendes und führendes und hierbei in der Art eines Druck- oder Arbeitszylinders wirkendes Führungsrohr aus nicht-magnetischem Material mit Ein- und Auslässen für das Druckmedium, einen mit dem Kolben fest verbundenen und innen entlang der

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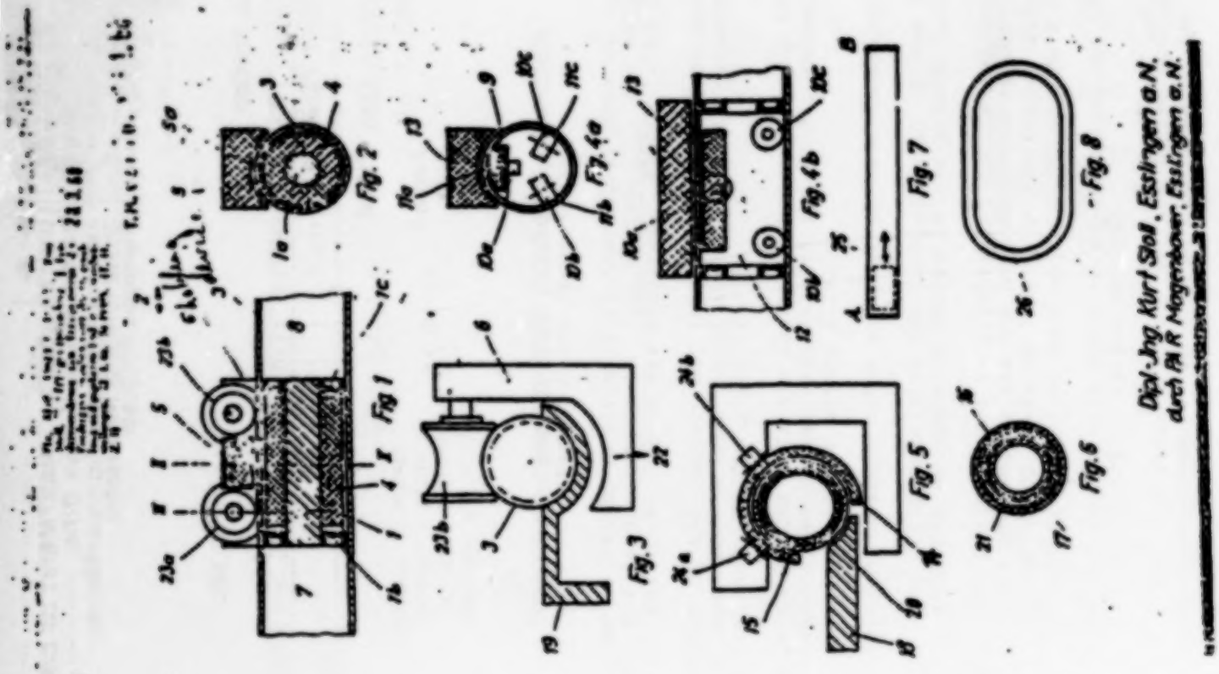


Dipl.-Ing. Kurt Stoll, Esslingen a.N.
durch ihr R. Mogenbauer, Esslingen a.N.





10. Fördervorrichtung nach Anspruch 8 oder 9, dadurch gekennzeichnet, daß der vorteilhaft länglich prismatische Kolben in den Bereichen seines vorderen und seines hinteren axialen Endes jeweils einen Dichtungsring trägt, der mit seiner äußeren Umfläche an der Rohrinnenwand anliegt.

11. Fördervorrichtung nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß der als vorteilhaft länglich-prismatisches Formstück ausgebildete Kolben im Bereich seiner beiden axialen Enden jeweils einen mit seinem Außenumfang an der Rohrinnenwand anliegenden Dichtungsring, z.B. aus Gummi oder Kunststoffmaterial und zwischen seinen Enden den ringartig ausgebildeten Innenmagneten trägt.

12. Fördervorrichtung nach einem der Ansprüche 1 bis 11, dadurch gekennzeichnet, daß die Halterung am Führungsrohr unter rollender Reibung geführt ist.

13. Fördervorrichtung nach Anspruch 12, dadurch gekennzeichnet, daß die Halterung als am Führungsrohr mit Hilfe von zwei im Bereich ihres vorderen und ihres hinteren Endes drehbar gelagerten Führungsrollen oder Führungsrollenpaaren verschieblich geführtes Formstück ausgebildet ist, dessen mittlerer Bereich den Außenmagneten trägt und mit der Lastaufnahme verbunden ist.







14. Fördervorrichtung nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Halterung am Führungsrohr führungsrollenlos allein unter Wirkung der entwickelten magnetischen Kraftflusses geführt ist.

15. Fördervorrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß der Innen- und/oder Außenmagnet als Permanentmagnet ausgebildet ist.

16. Fördervorrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß der Innen- und/oder Außenmagnet als Elektromagnet einstellbarer Stärke ausgebildet ist.

17. Fördervorrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß der Innen- und/oder Außenmagnet aus einer permanentmagnetischen Partie und einer ganz oder teilweise beliebig zu- und abschaltbaren elektromagnetischen Partie bestehen.

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Patent and Tr[redacted]mark Office,
ASSISTANT SECRETARY AND COMMISSIONER
OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

PAPER NO.

TITLE REPORT

A. PATENT FILE DATA

Serial No. 227,570 Filed 2-17-72

Patent No. 3,779,401 Issued 12-18-73

Inventor (s) -Full Name (s) (Continue on reverse side if necessary)

GEORGE CARROLL

DIVISION OF:

CONTINUATION OF:

CONTINUATION-IN-PART OF:

REISSUE OF :

SUBSTITUTE OF:

REEXAMINATION OF REEXAM NO:

B. ASSIGNMENT RECORD DATA

The assignment records reveal that the Title appears to be vested in;

☐ INVENTOR (s) R-3951 7-694

☐ AS ENDORSED Rec= 03-05-82

☐ AS THE RECORD NOW STANDS, THE PATENT, WHEN GRANTED WILL ISSUE IN THE NAME OF THE INVENTOR (s)

☐ LEGAL REPRESENTATIVE

☑ OTHER: Festo KG

Esslingen-Berkheim, west

Examined up to and Including: 3-18-88

This Certificate Dated 4-5-88

DIANE G. RUSSELE

EXAMINING OFFICER ASSIGNMENT DIVISION



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

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| Reexam Control No. | Filing Date | Patent Number | Paper No. |
|---|---|---|---|
| 90/001,477 | 3-18-88 | 3,779,401 | 3 |

DATE MAILED

APR 13, 1988

GERALD T. BODNER
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NOTICE OF REEXAMINATION REQUEST FILING DATE
(Patent Owner Requester)

Requester is hereby notified that the filing date of the request for reexamination is MAR 18, 1988, the date the required fee of $1,770.00 was received. 37 CFR 1.510 (d).

A decision on the request for reexamination will be mailed within three months from the filing date of the request for reexamination. 37 CFR 1.515 (a).

Pursuant to 37 CFR 1.33(c), future correspondence in this reexamination proceeding will be with the latest attorney or agent of record in the patent file.

The paragraphs checked below are part of this communication:

☐ 1. The party receiving the courtesy copy is the latest attorney or agent of record in the patent file.

☒ 2. The person named to receive the correspondence in this proceeding has not been made the latest attorney or agent of record in the patent file because:

☐ A. Requester's claim of ownership of the patent is not verified by the record.

☐ B. The request papers are not signed with a real or apparent binding signature.

☒ C. The mere naming of a correspondence addressee does not result in that person being appointed as the latest attorney or agent of record in the patent file.

☐ 3. Addressee is latest attorney or agent of record in the patent file.

☐ 4. Other. MR. BODNER THIS IS A FORM LETTER IN REGARD TO THE PWR OF ATTY. PER OUR CONVERSATION I AM WAITING FOR YOUR PWR OF ATTY

L. I. Batchelor
For the Manager Reexamination
Preprocessing Unit

cc:

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Washington, D.C. 20231

| Reexam Control No | Filing Date | Patent Number | Paper No |
|---|---|---|---|
| 90/001,477 | 3-18-88 | 3,779,401 | 4 |

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APR 14, 1988

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NOTICE OF ASSIGNMENT OF REEXAMINATION REQUEST
(SHORT VERSION)

1. The above identified request for reexamination has been assigned to Examining Group 310. All future correspondence to this proceeding should be identified by the control number listed above and directed to the assigned Examining Group.

2. A copy of this Notice is being sent to the latest attorney or agent of record in the patent file or to all owners of record. 37 CFR 1.33 (c). If the addressee is not, or does not represent, the current owner, he or she is required to forward all communications regarding this proceeding to the current owner(s). An attorney or agent receiving this communication who does not represent the current owner(s) may wish to seek to withdraw pursuant to 37 CFR 1.36 in order to avoid receiving future communications. If the address of the current owner(s) is unknown, this communication should be returned with the request to withdraw pursuant to Section 1.36.

L. L. Batchelor
For the Manager, Of Special
Handling Unit

cc:



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
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Washington, D.C. 20231

| FILING DATE | PATENT UNDER REEXAMINATION | ATTORNEY DOCKET NO |
|---|---|---|
| 03/18/88 | PAT NO 3779401 | |

GERALD T. BODNER
HOFFMAN & BARON
350 JERICHO TURNPIKE
JERICHO, NY 11753

| EXAMINER | |
|---|---|
| DOYLE J. | |
| ART UNIT | PAPER NUMBER |
| 217 | 5 |

DATE MAILED:
05/25/88

ORDER GRANTING/DENYING REQUEST FOR REEXAMINATION

The request for reexamination filed 3/18/88 has been considered. Identification of the claims, the references relied on and the rationale supporting the determination are attached.

Attachment(s): ☐ PTO-892 ☒ PTO-1449

ORDER:

1. ☒ The request for reexamination is GRANTED.

RESPONSE TIMES ARE SET TO EXPIRE AS FOLLOWS:

For Patent Owner's Statement:
TWO MONTHS from the date hereof. 37 C.F.R. 1.530(b).

For Requester's Reply:
TWO MONTHS from the date of service of any patent owner's statement. 37 C.F.R. 1.535.

Notes: If the patent owner does not file a timely statement under 37 C.F.R. 1.530(b), no reply from the reexamination requester will be considered. 37 C.F.R. 1.535.

The patent owner must submit, on a separate paper, the names of the attorneys or agents (maximum of three) which the owner desires to have printed on the reexamination certificate. If no names are submitted, none will appear on the certificate.

2. ☐ The request for reexamination is DENIED.

This decision is not appealable. 35 U.S.C. 303(c). Requester may seek review by a petition to the Commissioner within one month from the mailing date hereof. 37 C.F.R. 1.515(c).

In due course, a refund of $1200.00 will be made ☐ by treasury check or ☐ by credit to deposit account number _____ to the requester listed below unless notified otherwise. 35 U.S.C. 303(c).

CC:

DECISION

A substantial new question of patentability affecting claims 1-8 of United States Patent Number 3,779,401 is raised by the request for reexamination.

Extensions of time under 37 CFR 1.136(a) will not be permitted in these proceedings because the provisions of 37 CFR 1.136 apply only to "an applicant" and not parties in a reexamination proceeding. Additionally, Office policy requires that reexamination proceedings "will be conducted with special dispatch" (37 CFR 1.550(a)) and provides for extensions of time in reexamination proceedings as set forth in 37 CFR 1.550(c).

German Gebrauchsmuster No. 1,982,379 (newly cited in the Request for Reexamination) discloses an article feeding device comprising a body including an article transport device (or holder) and a magnet movably mounted on the outside of a non-magnetic cylinder wherein a magnetic piston inside the cylinder is moved back and forth in response to the supply and relief of hydraulic fluid within the cylinder, thereby moving the article transport device. The Taylor patent of record in the prosecution of U.S. patent no. 3,779,401 does not disclose an article transport device but rather a magnetic indicator on the outside of a cylinder which follows a magnetic piston within the cylinder to indicate the position of the magnetic piston.

As German document 1,982,379 discloses an article transport device which is movable in response to a hydraulically operated magnetic piston, which is a feature that was not found by the Examiner during the prosecution of the application which matured into the subject patent, and this feature is





material to the patentability of all of the claims in the patent, it is therefore determined that a substantial new question of patentability has been raised.

DOYLE:jf
703 557-3618
5/18/88

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ROBERT J. SPAR
SUPERVISORY PATENT EXAMINER
ART UNIT 317

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GROUP 310
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E. Key
7/27/88

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Reexamination Control No.: 90/001,477 Art Unit: 317

Filed: March 18, 1988 Examiner: J. Doyle

Patentee: George Carroll Docket: 163-5

U.S. Patent No.: 3,779,401 Date: July 21, 1988

For: PNEUMATIC DEVICE FOR MOVING ARTICLES

STATEMENT AND AMENDMENT UNDER 37 C.F.R. SECTION 1.530(b)

Commissioner of Patents
and Trademarks
Box REEXAM
Washington, D.C. 20231

Dear Sir:

In response to the Order dated May 25, 1988, granting the patent owner's request for reexamination, please amend the above-identified patent as follows:

In The Claims:

Please cancel claim 1 and substitute the following new claim therefor:

--9. A device for moving articles, which comprises:

a hollow cylinder formed of non-ferrous material and having opposite axial ends;

a piston mounted in the interior of the hollow cylinder and reciprocatingly slidable therein, the piston including a central mounting member disposed axially in the cylinder, a plurality of cylindrically-shaped permanent magnets mounted on the central mounting member and spaced apart axially from each other, each magnet having a bore formed axially therethrough for receiving the central mounting member, at least one pair of end members mounted on the central mounting member and disposed on opposite axial sides of the plurality of magnets, a pair of cushion members formed of resilient material, the



cushion members being situated near opposite axial ends of the central mounting member to help prevent damage to the piston when the piston contacts an axial end of the cylinder, and a pair of resilient sealing rings situated near opposite axial ends of the central mounting member and engaging the cylinder to effect a fluid-tight seal therewith;

a body mounted on the exterior of the hollow cylinder and reciprocatingly slidable thereon, the body including a plurality of annularly shaped permanent magnets surrounding the cylinder and spaced apart from each other, the permanent magnets of the piston and body being polarized so as to magnetically couple the body to the piston whereby movement of the piston inside the cylinder causes a corresponding movement of the body outside the cylinder, the body further including means provided thereon for holding on the body an article to be moved; and

means for controlling the admission of pressure fluid into the cylinder and exhaust fluid from the cylinder for moving the piston in the cylinder, the attractive forces between the permanent magnets of the piston and the body being such that movement of the piston causes corresponding movement of the body below a predetermined load on the body and such that above said predetermined load movement of the piston does not cause corresponding movement of the body.--

Please cancel claim 2.

Claim 3, line 1, change "2" to --9--;
line 2, change "in" to --on--.

Claim 5, line 1, change "1" to --9--.

Please cancel claims 7 and 8.

REMARKS

The order granting reexamination and the comments of the Examiner in the decision attached to the order are noted and

appreciated. The claims of the Carroll patent have been amended in a sincere effort to define more clearly and more specifically features of patentee's invention that distinguish over the art of record, including German Gebrauchsmuster No. 1,982,379, which was newly cited by the patent owner in its Request for Reexamination.

Main claim 1 of the Carroll patent has been replaced by new claim 9 submitted herewith for the Examiner's consideration. As will be discussed below, it is respectfully urged that the structure now set forth with particularity in claim 9 is not found in the art of record or in the German Gebrauchsmuster.

New claim 9 sets forth the structure of a device which may be used to transport articles, such as garments or clothing, from one site to another, and thus is particularly useful in the clothing industry where light loads are required to be moved at high speeds (Col. 1, lines 13-16 of the Carroll patent). With reference to a preferred form of the device illustrated by the drawings of the Carroll patent, claim 9 defines the device for moving articles as including a hollow cylinder (for example, cylinder 10 illustrated by Fig. 1) having opposite axial ends, and a piston (for example, piston 18) which is mounted in the interior of the cylinder and which slides back and forth in the cylinder.

Claim 9 specifically defines the piston as including a central mounting member (for example, bolt 21 shown in Fig. 3), a plurality of cylindrically-shaped permanent magnets (for example, magnets 20 shown in Figs. 3 and 5) mounted on the central mounting member, at least one pair of end members (members 22 shown in Fig. 3) mounted on the central mounting member and disposed on opposite axial sides of the plurality of magnets, and a pair of resilient sealing rings (rings 26 shown in Fig. 3) situated near opposite axial ends of the mounting member and engaging the cylinder to provide a fluid-tight seal.



Claim 9 also now more specifically defines the article moving device as including a pair of cushion members formed of resilient material. Such cushion members are illustrated by Fig. 3 of the Carroll patent and described in the patent specification, at Column 4, lines 13-16 thereof. Claim 9 specifically defines the cushion members as being situated near opposite axial ends of the central mounting member (i.e., bolt 21) to help prevent damage to the piston when the piston contacts an axial end of the cylinder.

Claim 9 also specifically defines the article moving device of the Carroll patent as including a body mounted on the exterior of the cylinder and being reciprocatingly slidable on the cylinder. The body is defined as including a plurality of annularly shaped permanent magnets (for example, magnets 28 shown in Figs. 3 and 5) surrounding the cylinder. Claim 9 defines the permanent magnets of the piston and body as being polarized, as shown in Figs. 4 and 5, so as to magnetically couple the body to the piston. Thus, and as set forth in new claim 9, movement of the piston inside the cylinder causes a corresponding movement of the body outside the cylinder.

Claim 9 also defines the body mounted on the cylinder as further including means for holding an article to be moved on the body. Such means can be in the form of the gripping device 30 shown in Fig. 1 of the Carroll patent.

Claim 9 further defines the article moving device of the Carroll patent as including means for controlling the admission of pressure fluid into the cylinder and exhaust fluid from the cylinder for moving the piston in the cylinder. An example of such fluid controlling means is the five part spool valve 40 illustrated by Fig. 1 of the drawings.

As in original claim 1, new claim 9 defines the attractive forces between the permanent magnets of the piston and the body

as being such that movement of the piston causes a corresponding movement of the body below a predetermined load on the body and such that above said predetermined load, movement of the piston does not cause corresponding movement of the body.

It is respectfully urged that the structure now set forth in new claim 9 patentably distinguishes over the references of record in the Carroll patent and newly cited German Gebrauchsmuster No. 1,982,379.

The German patent discloses a device for transporting goods. With reference to Figs. 1 and 2 of the German patent, the device includes a guide cylinder or tube 3 made from a non-magnetic material, a piston 1 which supports an inner magnet 4 and which reciprocatingly slides within the cylinder, and an outer magnet 5 mounted on the outside of the cylinder. The guide cylinder 3 also includes inlets and outlets for receiving and exhausting air or other pressure medium to effect reciprocal movement of the piston within the cylinder. The magnetic attraction between the inner and outer magnets causes the outer magnet to follow the piston in its movement within the cylinder.

It is respectfully urged that the particular structure of the inner piston and outer body now more specifically set forth in new claim 9 is not taught or suggested by the German patent. In particular, claim 9 defines the piston as including a plurality of spaced apart magnets, each in a cylindrical form, and also defines the outer body as including a plurality of spaced apart magnets, each in an annular form, as illustrated by Fig. 5 of the Carroll patent. None of the references cited during prosecution of the Carroll patent discloses the structure of an outer body formed of a plurality of spaced apart annular magnets and a piston formed of spaced apart cylindrical magnets, nor does the German patent disclose this structure. The German patent discloses a single inner magnet 4 and a single outer



magnet 5. The advantage of having not only a plurality of magnets on both the piston and the outer body but also spacing the magnets of the piston and body apart from each other is to increase the magnetic coupling between the two so that heavier loads may be transported by the outer body.

New claim 9 now also more specifically defines the article transport device of the Carroll patent as including cushions of resilient material mounted on the axial ends of the piston. As disclosed at Column 2, lines 13-16 of the Carroll patent specification, and as illustrated by Fig. 3 of the patent, the cushions are provided to prevent damage to the pneumatic device when the piston reaches the ends of the cylinder.

None of the references cited during prosecution of the Carroll patent discloses not only the overall structure of the article transport device set forth in claim 9, but also a pair of resilient cushions mounted on axial ends of a piston that is movable within a cylinder. Similarly, the German patent does not disclose resilient cushions mounted on the ends of piston 1. Accordingly, it would be possible for the piston of the device disclosed in the German patent to be damaged if it struck the closed ends of the cylinder.

In summary, new claim 9, which replaces original claim 1 of the Carroll patent, is respectfully urged to patentably distinguish over the references cited during prosecution of the Carroll patent and to distinguish over the German patent submitted by the patent owner for the Examiner's consideration in that the references and the German patent do not disclose the overall structure of the device for moving articles set forth in the claim, and in particular do not disclose 1) a <u>plurality</u> of cylindrically-shaped permanent magnets mounted on a central mounting member and <u>spaced apart axially from each other,</u> where each magnet has a bore formed axially therethrough for receiving

the central mounting member, 2) an exterior body including a plurality of annularly shaped permanent magnets spaced apart from each other and 3) a pair of cushion members formed of resilient material and situated near opposite axial ends of the central mounting member of the piston to help prevent damage to the piston when the piston contacts an axial end of the cylinder, as specifically set forth in new claim 9 submitted herewith.

Claim 2 of the Carroll patent has been cancelled, as the structure set forth in the claim has now been incorporated into new proposed claim 9.

Claim 3 has been amended so that it now directly depends from new claim 9.

Claim 5 has also been amended so that it now depends from new claim 9.

Claims 7 and 8 have been cancelled, as the structure set forth in these claims has now been incorporated into new proposed claim 9.

It is respectfully urged that the remaining dependent claims, that is, claims 3 through 6, as amended, patentably distinguish over the references cited in the Carroll patent and over the German patent for the reasons submitted above with respect to new main claim 9.

In view of the foregoing amendments and remarks, entry of new main claim 9 and the amendments to claims 3 and 5, and the issuance of a reexamination certificate with claims 3 through 6 and 9 are respectfully solicited.

Respectfully submitted,

Gerald T. Bodner

Gerald T. Bodner
Attorney for Patent Owner
Registration No. 30,449

GTB/cd





CERTIFICATE OF MAILING (37 CFR 1.8a)

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to the: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Claudia Deptula

Date 7/21/88

Claudia Deptula
(Signature of person mailing paper)

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

| REEXAM CONT NO | FILING DATE | PATENT UNDER REEXAMINATION | ATTORNEY DOCKET NO |
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| 90/001,477 | 03/18/88 | PAT NO 3779401 | D |

GERALD T. BODNER
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350 JERICHO TURNPIKE
JERICHO, NY 11753

| EXAMINER | |
|---|---|
| PAPERNER, L | |
| ART UNIT | PAPER NUMBER |
| 317 | 7 |

DATE MAILED: 08/25/88

This is a communication from the examiner in charge of this reexamination.

COMMISSIONER OF PATENTS AND TRADEMARKS

NOTICE OF INTENT TO ISSUE A REEXAMINATION CERTIFICATE AND/OR EXAMINER'S AMENDMENT

1. [X] Examination has been terminated in this reexamination proceeding and a Certificate will be issued in due course in view of:
   a. [X] Owner's communication filed July 25, 1988.
   b. [ ] Owner's late response filed _____.
   c. [ ] Owner's failure to file an appropriate response to the Office action/Notice of Appeal dated _____.
   d. [ ] Other
   The Certificate will indicate the following:
   a. Change in the Specification [ ] Yes [X] No
   b. Change in the Drawings [ ] Yes [X] No
   c. Status in the Claims:
      (1) Patent claims confirmed: _____
      (2) Patent claims amended: 3,4,5,6
      (3) Patent claims cancelled: 1,2,7,8
      (4) New claims allowed: 9
2. [X] Note attached statement of reasons for allowance and/or confirmation. Any comments considered necessary by owner regarding reasons for allowance and/or confirmation must be submitted promptly to avoid processing delays. Such submissions should be clearly labeled, "Comments on Statement of Reasons for Allowance and/or Confirmation."
3. [X] Note attached NOTICE OF REFERENCES CITED, PTO-892, which is part of this communication. The listed references are considered pertinent to the claimed invention, but the claims are deemed to be patentable thereover.
4. [X] Note attached LIST OF PRIOR ART CITED BY OWNER, PTO-1449, which is part of this communication and serves as an acknowledgment of receipt of owner's prior art statement. The references which were considered have been initialed on the form by the examiner and the claims are deemed patentable thereover.
5. [ ] The drawing correction request filed _____ has been [ ] approved. [ ] disapproved.
6. [ ] Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has: [ ] been received. [ ] not been received. [ ] been filed in parent application, Serial Number _____ filed on _____.
7. [ ] Note Examiner's Amendment below.
8. [ ] Other

EXAMINER'S AMENDMENT TO THE RECORD





Reasons For Allowance

Claims 3, 4, 5, 6, and 9 are deemed allowable over the prior art of record, including German Patent No. 1,982,379 because the prior art does not teach or render obvious the claimed combination which includes the plurality of magnets, end members, and cushion members in the claimed relationship.

The patent to Brown is cited to show cushion members. Miyamoto shows the basic combination but has a later effective date. The Figure 1 prior art embodiment is that shown in the cited United Kingdom Patent No. 1,317,105 (column 1, lines 21-29) but that patent corresponds to the patent reexamined in this application.

Paperner:vr
(703) 557-3618
8/23/88

LESLIE J. PAPERNER
PRIMARY EXAMINER
ART UNIT 317

G. Baron
8/25/88

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

NOTICE OF REFERENCES CITED

| SERIAL NO. | GROUP ART UNIT | ATTACHMENT TO PAPER NUMBER | |
|---|---|---|---|
| 90/001,477 | 317 | | 7 |

APPLICANT(S) Carroll

**U.S. PATENT DOCUMENTS**

| * | | DOCUMENT NO. | DATE | NAME | CLASS | SUB-CLASS | FILING DATE IF APPROPRIATE |
|---|---|---|---|---|---|---|---|
| | A | 1 1 6 2 5 6 2 | 11/1915 | Brown | 92 | 85R | |
| | B | 4 4 8 8 4 7 7 | 12/1984 | Miyamoto | 91 | Dig 4 | 10/1982 |
| | C | | | | | | |
| | D | | | | | | |
| | E | | | | | | |
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| | G | | | | | | |
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**FOREIGN PATENT DOCUMENTS**

| * | | DOCUMENT NO. | DATE | COUNTRY | NAME | CLASS | SUB-CLASS | PERTINENT SHTS. DWG. | PERTINENT PP. SPEC. |
|---|---|---|---|---|---|---|---|---|---|
| | L | | | | | | | | |
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| | Q | | | | | | | | |

**OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)**

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EXAMINER Ogrenner | DATE 8/22/88

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)



FORM PTO-122 (REV. 12-87)
U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

**TITLE REPORT**

PAPER NO. 8

**A. APPLICATION FILE DATA**

1. SERIAL NO. 001477 | 2. FILED

3. INVENTOR(S) — FULL NAME(S)

George Carroll

4. DIVISION OF

5. CONTINUATION OF

6. REISSUE OF

7. SUBSTITUTE OF 227,570-3779461

**B. ASSIGNMENT RECORD DATA**

The assignment records reveal that the Title appears to be vested in:

☐ (1.) Inventor(s)

☐ (2.) As endorsed

☐ (3.) As the record now stands, the patent, when granted, will issue in the name of the inventor(s).

☒ (4.) Other

| EXAMINED UP TO AND INCLUDING | THIS CERTIFICATE DATED |
|---|---|
| 08/12/88 | 11/22/88 |

BRANCH CHIEF OF ASSIGNMENT SEARCH BRANCH

DIANE G. RUSSELE

TFW.

156

FORM PTO-122 (REV. 12-87) — U.S. DEPARTMENT OF COMMERCE, PATENT AND TRADEMARK OFFICE

510

## TITLE REPORT

PAPER NO.

### A. APPLICATION FILE DATA

1. SERIAL NO. 05/227570 — 2. FILED 2/17/72

3. INVENTOR(S)—FULL NAME(S)

George Carroll

SEP 2 8 100

4. DIVISION OF

5. CONTINUATION OF

6. REISSUE OF

7. SUBSTITUTE OF

### B. ASSIGNMENT RECORD DATA

The assignment records reveal that the Title appears to be vested in:

- ☐ (1.) Inventor(s) Document herewith (2)
- ☐ (2.) As endorsed Rec. May 27, 1988
- ☐ (3.) As the record now stands, the patent, when granted, will issue in the name of the inventor(s).
- ☒ (4.) Other Festo KG Esslingen-Berkheim, West-Germany

| EXAMINED UP TO AND INCLUDING | THIS CERTIFICATE DATED | |
|---|---|---|
| 7-19-88 | | 8/9/88 |

BRANCH CHIEF OF ASSIGNMENT SEARCH BRANCH — DIANE G. RUSSELE

O.R.



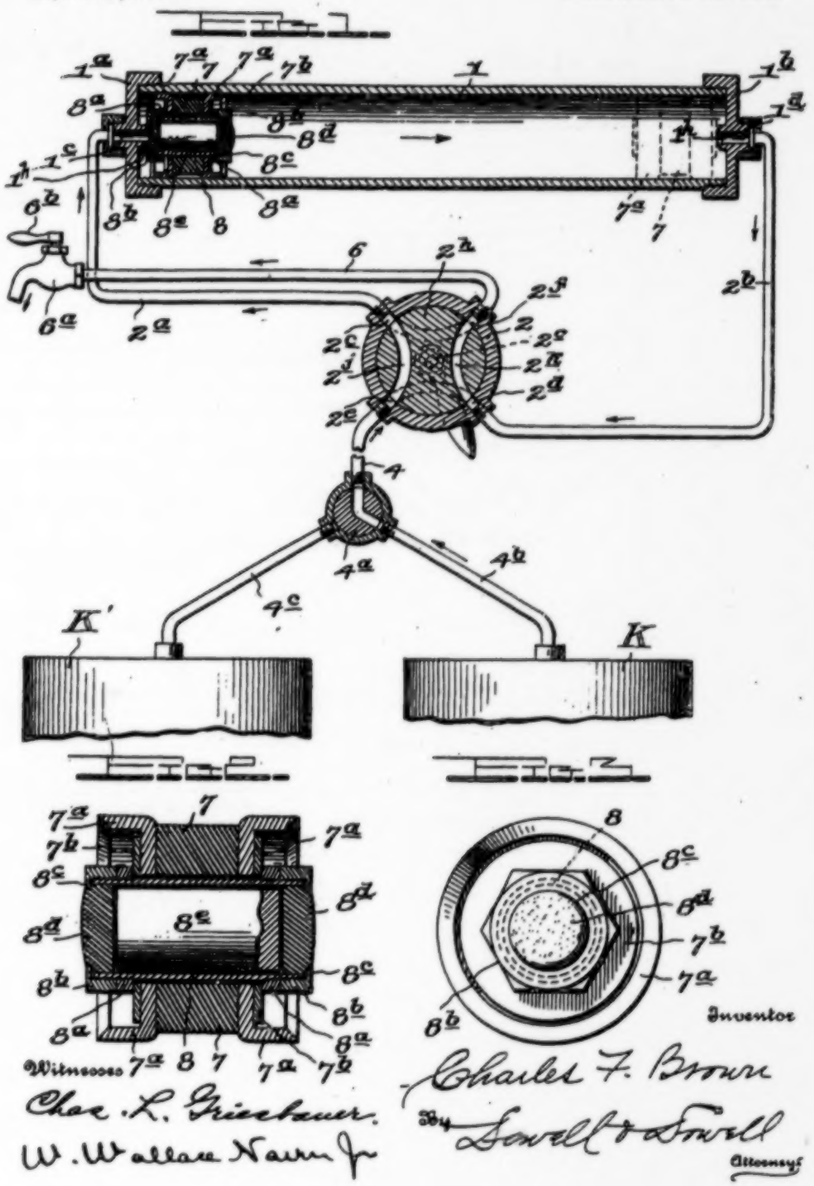
PATENT NUMBER: 3779401 ISSUE DATE: 12/18/73
SERIAL NUMBER: 05/227570 FILING DATE: 02/17/72
TITLE: PNEUMATIC DEVICE FOR MOVING ARTICLES
APPLICANT:
REEL: 3951 FRAME: 0494 DATE RECORDED: 03/05/82 NUMBER OF PAGES: 001
ASSIGNOR: CARROLL, GEORGE EXC DATED: 02/01/82
ASSIGNEE: FESTO KG, RUITER STRASSE 82, D-7300 ESSLINGEN-BERKHEIM, WEST -GERMANY
BRIEF: ASSIGNMENT OF ASSIGNORS INTEREST
RETURN ADDRESS: FIDDLER & LEVINE
350 FIFTH AVE.

C. F. BROWN.

PISTON VALVE FOR LIQUID MEASURING APPARATUS.

APPLICATION FILED FEB. 19, 1915.

1,162,562. Patented Nov. 30, 1915.






# UNITED STATES PATENT OFFICE.

CHARLES F. BROWN, OF NEW YORK, N. Y., ASSIGNOR TO UNIVERSAL LIQUID REGISTER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

## PISTON-VALVE FOR LIQUID-MEASURING APPARATUS.

1,162,562. Specification of Letters Patent. Patented Nov. 30, 1915.

Application filed February 19, 1915. Serial No. 9,340.

*To all whom it may concern:*

Be it known that I, CHARLES F. BROWN, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Piston-Valves for Liquid-Measuring Apparatus; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

This invention is a novel improvement in the pistons of liquid measuring apparatus of the type shown in my application for patent Serial No. 807,911, filed December 20, 1913; such apparatus comprising essentially a preferably cylindrical vessel and means whereby liquid can be admitted into either end of the vessel as it is being withdrawn from the other, direct communication within the vessel between the opposite ends thereof being cut off by means of a piston which moves back and forth in the vessel according to the flow of fluid therein.

The present invention has especial relation to such pistons, and its object is to construct such pistons so that they will effectually prevent communication between the interior portions of the vessel at opposite sides of the piston and prevent leakage of fluid therepast, and will also close the outlet ports in the ends of the vessel when they reach the ends of the vessel.

I will describe the invention in connection with the accompanying drawings in which—

Figure 1 represents a diagrammatical sectional elevation of a measuring apparatus with my novel piston therein. Fig. 2 is an enlarged sectional view of the piston detached. Fig. 3 is an end view of the piston.

The measuring apparatus comprises a preferably cylindrical vessel 1, closed at its ends by heads $1^a$ and $1^b$; head $1^a$ being provided with a central port $1^c$, and head $1^b$ with a central port $1^d$, to which ports are connected pipes $2^a$, $2^b$, which are respectively connected at their outer ends to ports $2^c$, $2^d$, of a four-way valve casing 2 which is also provided with a port $2^e$ communicating with a supply pipe 4; and with a port $2^f$ communicating with a pipe 6 connected to a dispensing faucet $6^a$ which can be operated manually by a handle $6^b$.

In the valve casing 2 is a valve $2^h$ having a stem $2^i$ to which is connected a handle by which the valve can be manually operated. The valve $2^h$ has two transverse ports $2^j$, $2^k$ which are so formed that when the valve is in one position port $2^j$ will establish communication between the ports $2^e$ and $2^c$; and simultaneously port $2^k$ will establish communication between the ports $2^d$ and $2^f$ (as illustrated in full lines in Fig. 1.) By turning the valve to the position indicated in dotted lines in Fig. 1, port $2^j$ will establish communication between the ports $2^e$ and $2^f$; and port $2^k$ will establish communication between the ports $2^c$ and $2^d$. The pipe 4 communicates with a supply valve $4^a$ which preferably has two inlet ports connected by pipes $4^b$, $4^c$ to two containers K, K'; and by properly shifting valve $4^a$ communication can be established alternately between the pipe 4 and either container K or K'.

The vessel 1 is made of such size that it will contain a predetermined quantity of liquid, say one pint or one quart, and the introduction of such a quantity of liquid into the cylinder will force the piston to one end thereof.

The parts thus far described are similar to those shown and described in my aforesaid application.

Within the vessel 1 is a novel piston which is movable longitudinally of the cylinder and is adapted to be moved by the liquid admitted into the cylinder as hereinafter explained. This piston forms the subject-matter of the present invention and is constructed as follows: An annular body 7, preferably made of hard rubber and slightly less in external diameter than the interior of the vessel 1, is interposed between oppositely facing cup leathers or washers $7^a$ whose peripheral flanges are adapted to fit closely against the circular inner wall of the vessel 1. The body and cup washers are strung upon an axial member 8, which is preferably tubular and is exteriorly threaded on its outer ends for engagement of nuts $8^a$ which clamp the cup leathers firmly against the body; flat ring washers $7^b$ are preferably strung on the axial member 8 between the nuts $8^a$ and the washers. Detachably attached to the ends of the axial member 8 are cushions $8^d$, preferably formed of rubber or other suitable yieldable or resilient material. These cushions $8^d$ may be spaced apart by a

filler 8ᵉ within the sleeve 8 and are secured in position by means of nuts 8ᵇ screwed on the member 8 and provided with inwardly projecting flanges 8ᶜ on their outer ends whose internal diameter is slightly larger than the external diameter of the nipples 1ᵇ surrounding the inner ends of the ports 1ᶜ, 1ᵈ of the vessel.

The operation of the apparatus is as follows: If the valve 2ᵇ is in the position shown in Fig. 1, and the faucet 6ᵃ be opened; liquid will flow from the container K through pipe 4ᵇ, valve 4ᵃ, pipe 4, port 2ᶠ, pipe 2ᵃ and port 1ᶜ into the vessel 1, and the liquid will force the piston 7 in said vessel toward the head 1ᵇ thereof; and at the same time the liquid contained in the vessel between the piston 7 and head 1ᵇ will be discharged through the port 1ᵈ, pipe 2ᵇ, port 2ᵉ, pipe 6, and faucet 6ᵃ. When the piston 7 moves against the head 1ᵇ (as indicated in dotted lines in Fig. 1) its cushion 8ᵈ closes the port 1ᵈ and no more liquid escapes through the faucet; and no more liquid can enter the measuring vessel 1 through port 1ᵇ. When no more liquid escapes through the pipe 6, valve 2ᵇ may be shifted so as to establish communication between pipes 4 and 2ᵇ; and between pipes 2ᵃ and 6 (as indicated in dotted lines in Fig. 1,) and then if the faucet 6ᵃ be opened, liquid will flow from the supply through pipes 4 and 2ᵇ into the vessel 1 through port 1ᵈ and force piston 7 to the left; and liquid will be discharged through the port 1ᶜ and pipes 2ᵃ and 6 until the piston reaches the head 1ᵃ of the vessel, and port 1ᶜ is closed by the adjacent cushion 8ᵈ on the piston 7; then no more liquid will escape through pipe 6, until the valve 2ᵇ is again shifted to the position shown in full lines in Fig. 1. By shifting the valve 2ᵇ communication is established alternately between the supply and the opposite ends of the vessel 1, and between the opposite ends of said vessel and the faucet; but at no time can direct communication be established between the supply and the faucet.

It will be seen that when pressure is brought to bear against the cup leathers from either end of the vessel it presses the lips or flanges of such cup leathers outward against the walls of the vessel, and the harder the pressure the more certainly will the piston eliminate the air or gas in the vessel, and prevent passage of gas or liquid past the piston from one end of the vessel to the other. My piston overcomes the difficulties which have been experienced with the pistons formerly used in such vessels, owing to the fact that the drawn tubing (from which the vessel is ordinarily made) will always vary somewhat in diameter owing to uneven contraction in cooling off. But by the use of my piston an even measure is always delivered from each end of the vessel. The flanged nuts 8ᵇ hold the cushions 8ᵈ [illegible] against the ends of the filler block 8ᵉ in the axial member 8, thus insuring that the cushions will perfectly seal the ports in the ends of the cylinder. When the filler 8ᵉ is loosely fitted in the member 8 it permits pressure to be transmitted directly through the filler from one cushion to the other.

The cup leathers preferably have lips of about one-half inch in length and will last for years without replacing same, as they will wear principally from the ends, whereas a flat washer placed around the circumference of a piston head will wear off and become smaller by the constant friction and will require frequent replacing.

What I claim is:

1. A piston comprising a tubular axial member, an annular body strung on said member, oppositely facing cup leathers on said axial member at opposite sides of the body member, and resilient cushions detachably attached to opposite ends of the axial member.

2. A piston comprising a tubular axial member having threaded ends, an annular body strung on said axial member, oppositely facing cup leathers on said axial member at opposite sides of the body, resilient cushions at opposite ends of the axial member, flanged nuts screwed on the ends of the body member and holding said cushions in position, and a filler in the tubular axial member interposed between said cushions.

3. A piston for the purpose specified, comprising an axial member, a body member on said axial member, oppositely facing cup leathers strung on said axial member at opposite sides of the body member, means on the axial member for clamping the cup leathers to the body member, cushion members at the opposite ends of the axial member, and annular flanged nuts screwed on the ends of the axial member and holding said cushion members in position, substantially as described.

In testimony that I claim the foregoing as my own, I affix my signature in presence of two witnesses.

CHARLES F. BROWN.

Witnesses:
PATK. CONNOLLY,
GUSTAVE VAN BOWBRAEBEN.



Aug. 10, 1948. D. W. MacLEOD ET AL 2,446,657

INDICATOR FOR RUBBER MIXERS OR THE LIKE

Filed Sept. 26, 1947 2 Sheets-Sheet 1

Fig. 1.

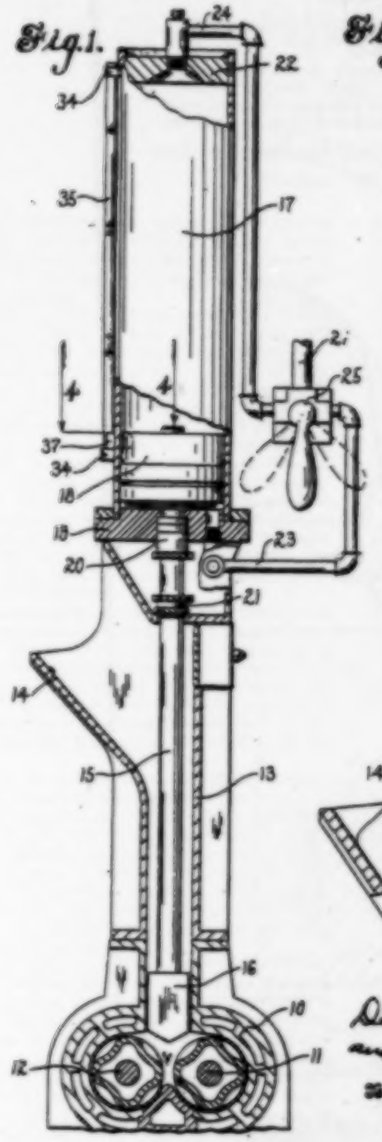
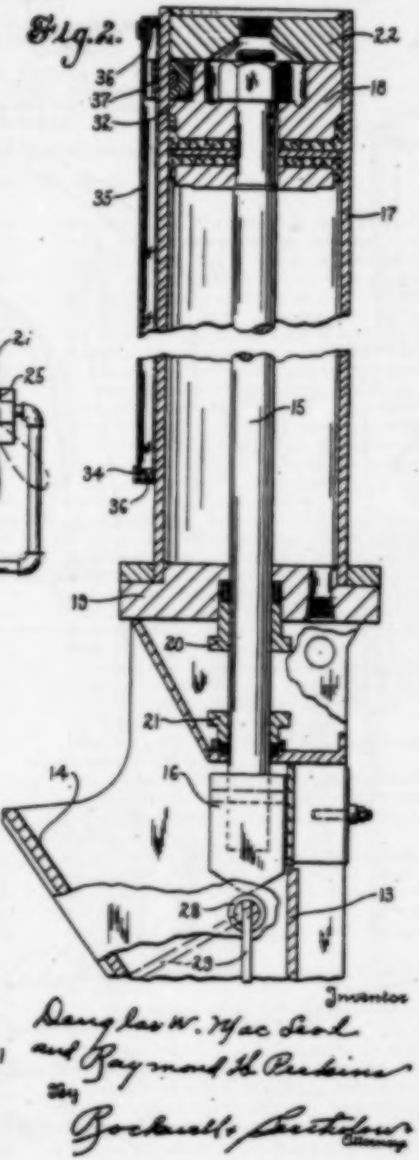



Fig. 2.

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Aug. 10, 1948. D. W. MacLEOD ET AL. 2,446,657

INDICATOR FOR RUBBER MIXERS OR THE LIKE

Filed Sept. 26, 1947 2 Sheets-Sheet 2

Fig. 3.

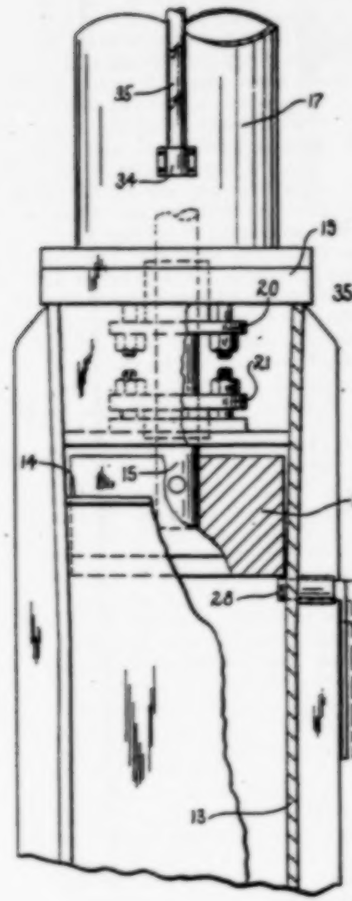



Fig. 4.

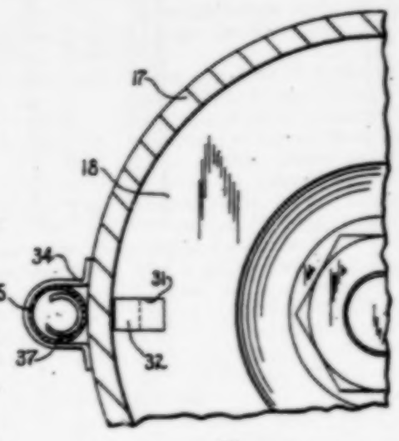
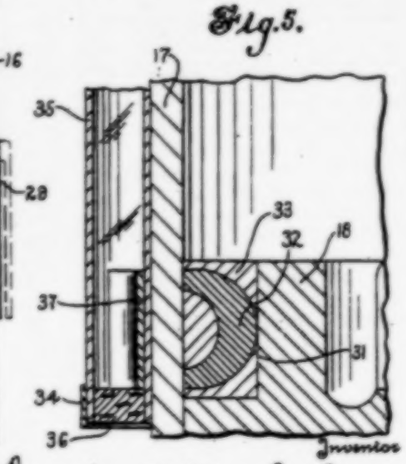



Fig. 5.

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Patented Aug. 10, 1948 2,446,657

# UNITED STATES PATENT OFFICE

2,446,657

## INDICATOR FOR RUBBER MIXERS OR THE LIKE

Douglas W. MacLeod, Ansonia, and Raymond H. Perkins, Milford, Conn., assignors to Farrel-Birmingham Company, Inc., Ansonia, Conn., a corporation of Connecticut

Application September 26, 1947, Serial No. 776,182

7 Claims. (Cl. 18—2)

1

This invention relates to indicators for pistons or plungers, and more particularly to a device which will indicate the position of the piston or plunger of a machine, such as a rubber masticator, for example.

In machines where there is employed a piston or plunger operated by fluid pressure, it is very often desirable for the operator to know the position of the plunger at any time. As the plunger is operated by fluid pressure, the cylinder within which the piston or plunger operates must be made of material which will withstand the pressure which it is necessary to employ, and, for this reason, it is often impossible to make the cylinder of transparent material. It is, therefore, impossible for the operator to know the position of the plunger, and it is many times impracticable to arrange for a part of the plunger or an indicator on the plunger to project through the cylinder or other part of the device to give an indication of its position.

It is contemplated by the present invention to indicate the position of the piston or plunger magnetically, and to effect this result the piston is made of non-magnetic material, and a permanent magnet is attached to, or incorporated in, the piston, which magnet is of sufficient strength to act through the wall of the cylinder upon a follower or the like disposed at the outside of the cylinder.

As shown in the present application, the cylinder is also made of non-magnetic material, and upon the outer wall of this cylinder is secured a transparent tube extending longitudinally of the cylinder. Within this tube is disposed a freely slidable follower of magnetic material of light weight, so that it will be attracted by the magnet and move along the tube with the piston, thus indicating the position of the latter at all times to the operator of the machine.

Although capable of other application, the indicating device is shown in the present instance as being applied to the plunger or piston of a rubber masticator. A machine of this character is provided with a chamber within which the masticator rotors are mounted, and a charging stack is positioned above the chamber through which the material to be acted upon by the rotors is fed into the chamber. Slidably mounted in this charging stack is a weight or closure member designed to be moved upwardly to a position to permit the charging of the material into the chamber, and, after the latter has been charged, to be moved downwardly to maintain pressure upon the charge while it is being acted upon by

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the rotors. To this weight is secured a plunger which extends into a cylinder mounted above the charging stack and a piston is secured to the plunger within the cylinder, so that the plunger and weight may be operated by fluid pressure admitted to the cylinder in order that the weight may be held downwardly upon the charge under pressure. The indicator is mounted upon the outside of the cylinder and arranged to be moved by a magnet which is, in this instance, mounted in the piston itself.

One object of the present invention is to provide a mechanically-operated piston or plunger with an indicator which will indicate the position of the piston upon the outside of the cylinder within which the piston moves.

A still further object of the invention is to provide a machine, such as a rubber masticator, for example, with an indicator to indicate the position of the plunger or weight in the charging stack, the indicator being positioned without the cylinder within which the plunger-operating piston is mounted, and being arranged to be operated by movements of the piston.

To these and other ends the invention consists in the novel features and combinations of parts to be hereinafter described and claimed.

In the accompanying drawings:

Fig. 1 is a sectional view of a rubber masticator embodying our invention;

Fig. 2 is an enlarged sectional view of the upper portion of the charging stack and cylinder mounted thereon showing the plunger in its raised position;

Fig. 3 is a fragmentary front elevational view of the upper portion of the charging stack, some parts being broken away for the sake of clearness;

Fig. 4 is a partial sectional view on line 4—4 of Fig. 1; and

Fig. 5 is a partial vertical sectional view through the piston.

To illustrate a preferred embodiment of our invention, we have shown in Fig. 1 of the drawings a machine, such as a rubber mixer or masticator, the machine embodying a double cylindrical chamber 10 within which are mounted bladed rotors 11 and 12 which cooperate in a well-known way to mix, masticate, and reduce to plastic form, a charge of rubber or other material which may be introduced into the chamber. It will be understood that, while a double rotor machine is shown, our improvements may be employed in connection with a rubber masticator having a

single rotor, and may likewise be employed with types of machines other than masticators.

Above the chamber is mounted the charging stack 13 through which the charge may be introduced into the chamber, this stack being provided with a charging opening 14. Slidably mounted in the stack is a piston rod or plunger 15 to the lower end of which is secured a weight or closure member 16, this weight being adapted, during the operation of the device, to rest upon the charge within the chamber and exert pressure thereon. It, of course, also acts to force into the chamber the material introduced into the charging stack through the opening 14.

Mounted above the charging stack is a cylinder 17, and the plunger or piston rod 15 extends into this cylinder, and secured to its upper end is the piston 18 slidably mounted within the cylinder. The lower end of the cylinder is closed by the head 19, and the piston rod passes through a packing gland 20 secured in the head 19 and also through a gland 21 secured in a portion of the upper end of the stack.

The upper end of the cylinder is closed by the head 22, and pressure fluid is introduced above and below the piston 18 through the lines 23 and 24, which lead from a suitable valve 25 controlling the introduction of fluid pressure into one or the other of the lines 23 and 24 from the line 26 leading to a source of supply. It will, of course, be obvious that, when pressure fluid is introduced to the line 23 below the piston, the weight 16 will be caused to rise, and, when fluid pressure is introduced into the cylinder through the line 24 above the piston, the weight will be caused to descend and exert pressure on the charge in the usual manner.

The upper and lower positions of the weight 16 are determined by the upper and lower heads of the cylinder, and this weight may be held in its upper position, as shown in Fig. 3, by a stop 27 mounted in the wall of the stack and manipulated to or from engagement with the weight by the handle 28.

In order to provide indicating means upon the outside of the cylinder 17, the piston 18 is composed of non-magnetic material, such as brass, for example, and in a recess 31 adjacent the periphery of the piston is mounted a permanent magnet 32 of some material which can be strongly magnetized, such, for example, as the metal "alnico." As shown, this magnet is of semi-cylindrical form, so as to present two poles at the exterior of the piston adjacent the wall of the cylinder. The magnet may be held in place by solder or the like 33.

The cylinder wall is also made of non-magnetic material, preferably some type of non-magnetic metal, as it must be sufficiently strong to withstand the high pressure of the pressure fluid used therein. Secured upon the outside of the cylinder by clips or the like 34 is a tube 35 of transparent material, such as transparent plastic, for example, the upper and lower ends of this tube being closed by plugs 36. Within this tube is mounted a follower 37 of magnetic material, this follower being, as shown, in the form of a hollow semi-cylindrical body, so that it will slide freely upwardly and downwardly in the tube 35 and, at the same time, be of relatively light weight, so that it will be attracted by the magnet 32 and be carried with the movements of the piston. It will be apparent that, as the piston moves within the cylinder 17, the indicator 37 will also move within the tube 35 and will at once indicate to the



operator through the transparent tube the position of the piston and, therefore, the position of the weight 16.

In the case of some operations, such as the mastication of rubber, for example, the chamber may be charged with lumps of rubber which, when the operation is first begun, will remain in the charging stack 13. During the operation of the machine, the level of the charge will rise and fall to a considerable extent under the pressure of the rotor blades and cause the weight to reciprocate within the stack. The amount of these oscillations or reciprocations will be indicated by the follower 37. When, however, the charge is reduced to plastic form, it will be contained wholly or largely within the chamber 10, and the weight 11 will be moved to its lower position which will also be indicated by the follower. Thus the action of the follower will indicate to the operator the condition of the mass being treated within the chamber.

While we have shown and described a preferred embodiment of our invention, it will be understood that it is not to be limited to all of the details shown, but is capable of modification and variation within the spirit of the invention and within the scope of the claims.

What we claim is:

1. In a mixing or masticating machine, a chamber having an opening, a cylinder supported above the chamber, a piston in the cylinder, a weight connected to the piston and adapted to extend into said opening, a magnet carried by the piston and having pole portions substantially flush with the outer surface thereof, and a follower of magnetic material disposed at the outside of the cylinder and adapted to be moved therealong by said magnet.

2. In a device of the class described, a chamber, a cylinder, a pressure-fluid-operated piston therein, a plunger connected to the piston and extending toward the chamber, means to indicate the position of the piston in the cylinder comprising a magnet carried by the piston and having pole portions substantially flush with the outer surface thereof, a follower disposed on the outside of the cylinder wall and adapted to be moved by said magnet, and a guide tube on the cylinder within which the follower is mounted.

3. In a device of the class described, a machine having a piston-operated member and including a cylinder and a piston therein connected to said member, means to indicate the position of the piston comprising a magnet embedded in the piston and exposed at the lateral face of the piston adjacent the inner surface of the cylinder wall, a guide member on the outside of the cylinder wall and extending longitudinally thereof, and a follower freely movable in said guide member and adapted to be moved by said magnet as the piston is moved.

4. A machine for treating plastic material comprising a chamber, a piston rod extending into the chamber, an element on said rod exerting pressure on the material in the chamber, a piston connected to said rod, a cylinder within which said piston operates, means for introducing fluid pressure into the cylinder, a magnet embedded in the piston and having pole portions exposed at the lateral face of the piston, and a follower of magnetic material slidably mounted on the outside of the cylinder and adapted to be moved by the magnet.

5. A rubber masticating machine comprising a chamber, a charging stack communicating







with the chamber, a weight slidably mounted in said stack, a cylinder supported upon the stack, a piston within the cylinder connected to said weight to move the same, means for introducing fluid pressure into the cylinder to move the piston, a permanent magnet embedded in the piston and having opposite pole portions exposed at the lateral face of the piston, an indicating means mounted upon the outside of the cylinder, said means comprising a follower of magnetic material adapted to be moved by said magnet, and guide means to maintain said follower against the cylinder wall.

6. A rubber masticating machine comprising a chamber, a charging stack communicating with the chamber, a weight slidably mounted in said stack, a cylinder supported upon the stack, a piston within the cylinder connected to said weight to move the same, means for introducing fluid pressure into the cylinder to move the piston, a permanent magnet embedded in the piston and exposed at the lateral surface thereof, an indicating means mounted upon the outside of the cylinder, said means comprising a follower of magnetic material adapted to be moved by said magnet, and guide means to maintain said follower against the cylinder wall, said guide means comprising a tubular member of transparent material within which the follower is mounted.

7. A rubber masticating machine comprising



a chamber, a charging stack communicating with the chamber, a weight slidably mounted in said stack, a cylinder supported upon the stack, a piston within the cylinder connected to said weight to move the same, means for introducing fluid pressure into the cylinder to move the piston, a permanent magnet carried by the piston, an indicating means mounted upon the outside of the cylinder, said means comprising a follower of magnetic material adapted to be moved by said magnet, and guide means to maintain said follower against the cylinder wall, said follower comprising an element of hollow semi-cylindrical form, and said magnet being of semi-cylindrical form and presenting opposite poles substantially flush with the lateral surface of the piston.

DOUGLAS W. MacLEOD.
RAYMOND H. PERKINS.


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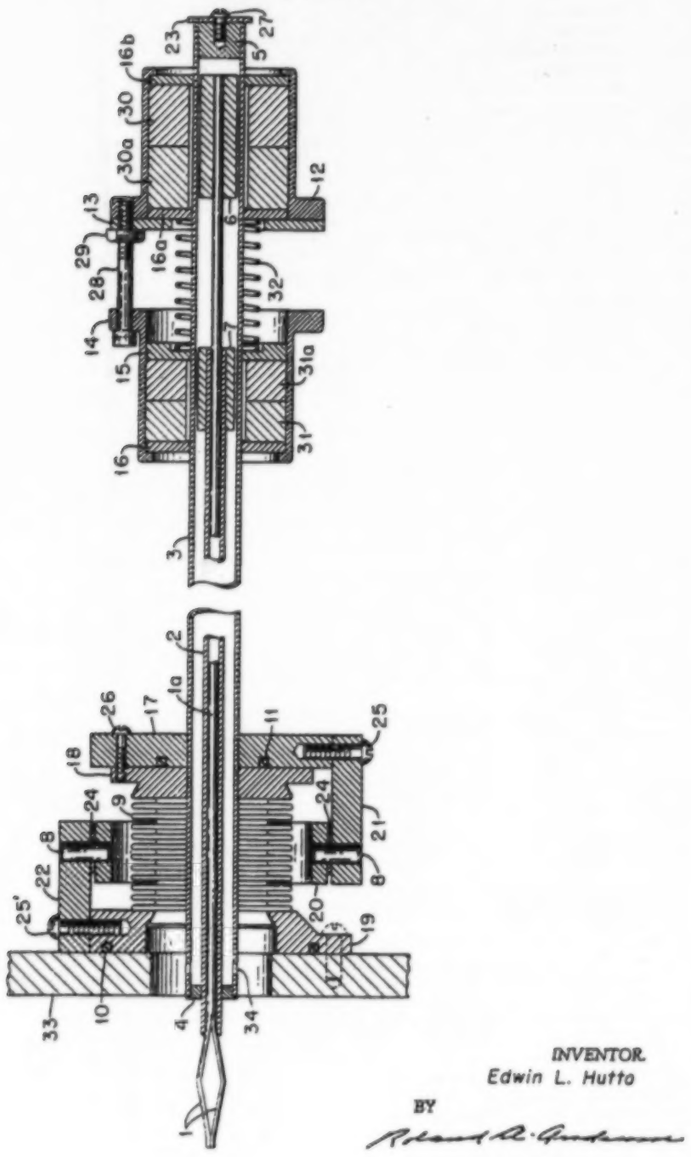
Aug. 15, 1961 E. L. HUTTO 2,996,330

REMOTELY OPERATED MANIPULATOR

Filed Nov. 12, 1959




INVENTOR.
Edwin L. Hutto

BY

ATTORNEY



United States Patent Office 2,996,330 Patented Aug. 15, 1961



2,996,330

# REMOTELY OPERATED MANIPULATOR

Edwin L. Hutto, Oak Ridge, Tenn., assignor to the United States of America as represented by the United States Atomic Energy Commission

Filed Nov. 12, 1959, Ser. No. 852,583
2 Claims. (Cl. 294—88)

This invention relates to a means for performing, within an entirely enclosed cell containing radioactive materials, various mechanical operations—specifically the transfer of radioactive samples from carrier to sampler and the opening of the same for analysis of the contents thereof.

Many manipulators, both simple and complex, have been developed in the prior art for accomplishing various operations with the isolated cells wherein radioactive materials are processed. Some of these manipulators have been mechanical, others pneumatic or hydraulic, still others electrical, and more often a mixture of these basic manipulating means have been used. Typical of these are the type which utilize a pantograph type of operation over the top of a wall of the cells to duplicate inside the cell the movements performed outside. This necessitates an opening in the cell. Another type uses a plurality of endless belts to transmit the motion. This also necessitates an opening into the cell.

A large proportion of the other prior art manipulators also require some opening into the cell through which some mechanical portion of the motion is accomplished. If these openings are placed so as to prevent radiations from penetrating the same, such manipulators are useful for most radioactive materials. However, when the radioactive materials are volatile or are easily scattered, as in the case of plutonium, the cell must be completely closed, thus obviating the use of many of the prior art manipulators.

Some prior art manipulators are electro-mechanical and require no openings through the cell wall, such as disclosed in U.S. Patent No. 2,476,249. However, they are too complex for small operations. It is desirable to provide a relatively inexpensive and simple manipulator for use in a completely enclosed cell.

With a knowledge of the complexity of the prior art manipulators for use with enclosed cells, it is a primary object of this invention to provide a simple and inexpensive manipulator wherein the "driver" is positioned outside a hot cell and the "slave" or driven portion is within the cell, and the cell is maintained airtight.

It is another object of this invention to provide a manipulator with a minimum of movable parts, which is simple to operate, and which is essentially leak free.

These and other objects and advantages of this invention will become apparent from a consideration of the following detailed specification and the accompanying drawing, wherein:

The single figure is a cross sectional view of the manipulator designed to accomplish the above stated objects.

The above objects have been accomplished in the present invention by providing a rod which is slidable within a tubular sleeve. The rod has a pair of fingers affixed thereto which may be separated by relative movement between the rod and sleeve. The rod and sleeve are enclosed in a tubular member, the rod being longer than the sleeve. A magnetic follower of magnetizable material is affixed to the end of the sleeve that extends out of the cell, and another magnetic follower is affixed to the end of the rod. A permanent magnet is enclosed in a sleeve member which slides on the tubular member and the magnet is disposed adjacent to the magnetic follower fixed to the sleeve. Another permanent magnet is enclosed in another sleeve member slidable on the tubular member and the other magnet is disposed adjacent to the magnetic follower fixed to the rod. The respective sleeve members are held in a fixed position with respect to each other by a compression spring so as to normally hold the fingers on the cell end of the rod closed. The sleeve members may be moved toward each other to impart relative motion between the rod and sleeve to thus open the fingers. When the sleeve members are moved as a unit, the rod and sleeve may be moved in an axial direction, or be rotated about their axis by the action of the magnets upon the magnetic followers. The tubular member enclosing said rod and sleeve is sealed to an opening in the cell by means of a flexible bellows in such a manner that additional motion may be imparted to the fingers in at least two planes.

Refer now to the drawing, which illustrates one embodiment in which the principles of this invention may be carried out. A central rod 1*a* extends centrally through the entire unit and terminates in formed tong fingers 1, which extend through a hole in one wall 33 of the cell. Encircling the rod 1*a* is a guide tube 2, and spaced coaxially therefrom is a closure tube 3. A bushing 4 closes one end of the annulus between the guide tube 2 and closure tube 3, and serves as a bearing for the guide tube 2. A plurality of openings 34 are provided in closure tube 3 adjacent to bushing 4 to provide for movement of air into and out of tube 3 to allow freedom of movement of rod 1*a* and guide tube 2 within tube 3. The outer end of the closure tube 3 is made airtight by a plug 5 inserted therein. The rod 1*a* is longer than the guide tube 2 and extends beyond the outer end thereof. A cylindrical soft iron magnet core 6 surrounds, and is attached to, the outer end of rod 1*a*. A similar core 7 surrounds, and is attached to, the outer end of guide tube 2.

An airtight and yet flexible connection between the closure tube 3 and cell wall 33 is provided by a multiconvolution bellows 9. One end of the bellows is sealed by brazing to an adaptor plate 19 which, in turn, is removably fastened to the cell wall 33. An O-ring 10 provides a seal between plate 19 and wall 33. The other end of the bellows 9 is sealed by brazing to an adaptor ring 18. This ring 18 is removably secured to a terminal plate 17 by screws 26, only one of which is shown. Plate 17 is sealed by brazing to the outer surface of the closure tube 3. A seal between ring 18 and plate 17 is provided by an O-ring 11.

In order to eliminate undue strain on the bellows 9, a gimbal-like structure is provided by a ring 20 surrounding the bellows 9. Ring 20 is supported on four pins 8, two of which, in turn, mate through washers 24 into a pair of blocks 21, only one of which is shown, attached to terminal plate 17 by screws 25. The other two pins 8 mate through washers 24 into a pair of blocks 22, only one of which is shown, attached to adaptor plate 19 by screws 25'. Thus the enclosure tube 3 may be non-rotatably pivoted about a point in the center of ring 20 to provide side-to-side and up-and-down motion, or a combination thereof, of the tong fingers 1.

Rotary and axial motion of the tong fingers 1, as well as opening and closing of the fingers 1, is accomplished by movement of at least a portion or all of four circular magnets 31, 31*a* and 30, 30*a*, which encircle the outer extremity of closure tube 3. The magnets 30, 30*a* are enclosed in a sleeve 12 and restrained therein with a pair of washers 16*a*, 16*b*. A plate 13 completes the housing. The magnets 31, 31*a* are enclosed in a similar sleeve 14 and are restrained therein with washers 15, 16. A repulsive force is applied between the magnet assemblies by a spring 32. The maximum separation of the assemblies is established by a plurality of adjustable in-

dexing studs 28, only one of which is shown. Studs 28 pass through sleeve member 14 and threadably engage sleeve member 12. Lock nuts 29 are provided to prevent studs 28 from rotating once they have been adjusted to provide the desired spacing between the magnet assemblies.

The magnet assemblies are slidable along the enclosure tube 3 but are prevented from disengagement therewith by a washer 23 releasably secured to the plug 5 by a screw 27. It can be seen in the figure that the maximum spacing between the magnet assemblies is chosen so that they respectively encircle the magnetic core 6 attached to the rod 1*a* and the magnetic core 7 attached to the guide tube 2. The value of this maximum spacing is chosen to cause the tong rod 1*a* to be drawn into the guide tube 2 to a maximum distance so as to close fingers 1. The fingers 1 may then be opened by moving the magnet assemblies, and thus the magnetic cores 6, 7 toward each other so as to move the tong rod 1*a* axially within guide tube 2.

The tong fingers may be moved further into the cell by movement of the entire magnet assembly toward the cell wall 33, and withdrawn by movement of the entire magnet assembly in the reverse direction. The tong fingers may be rotated about the axis of the tong rod 1*a* by rotating the magnet assemblies about the axis of the closure tube 3. Also, as discussed above, limited up-and-down and side-to-side motion of the tong fingers 1 may be made by movement of the closure tube 3 in those planes. It may thus be seen that the above manipulator may be moved with little limitation without the use of sliding or rotating seals, since the rod 1*a*, sleeve 2, and the magnetic cores 6, 7 are sealed within closure tube 3 so that the problems of leaks are essentially eliminated.

This invention has been described by way of illustration rather than limitation and it should be apparent that other changes in the arrangement of the various parts of my invention as shown and described may be resorted to without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. An improved remotely operated manipulator for use in an enclosed cell provided with a manipulator opening and containing radioactive materials, comprising an elongated rod provided with fingers on one end, a sleeve shorter than and slidably fitted on said rod, a tubular member enclosing said rod and its sleeve and coaxially spaced therefrom, a bushing positioned in one end of said tubular member, said bushing having a central opening which acts as a sliding bearing for said sleeve, a plug disposed in the other end of said tubular member, means for supporting and for flexibly sealing said one end of said tubular member within said opening in said cell, said fingers and a portion of said rod and one end of said sleeve extending into said cell, a first magnetic follower affixed to the other end of said rod, a second magnetic follower affixed to the other end of said sleeve, a first sleeve member slidable upon said tubular member, a first permanent magnet disposed in said first sleeve member and positioned in a magnetic coupling relation to said first magnetic follower, a second sleeve member slidable upon said tubular member, a second permanent magnet disposed in said second sleeve member and positioned in a magnetic coupling relation to said second magnetic follower, means for coupling said sleeve members together, said coupling including resilient means disposed between said sleeve members, said resilient means acting in cooperation with said magnetic couplings for urging said sleeve against the base ends of said fingers to hold them closed, said resilient means adapted to be compressed by movement of said sleeve members toward each other to effect relative movement between said rod and sleeve by means of said magnetic couplings to thereby open said fingers, said rod and sleeve being manually movable in unison along the axis and rotatable about the axis of said rod relative to said tubular member by action of said magnets upon said followers to thereby effect movement of said manipulator to a plurality of selected longitudinal and axial positions.

2. The manipulator set forth in claim 1, wherein a third permanent magnet is disposed in said first sleeve member and in a magnetic coupling relation to said first magnetic follower, and a fourth permanent magnet is disposed in said second sleeve member and in a magnetic coupling relation to said second magnetic follower.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MANUALLY OPERATED HYDRAULIC ACTUATOR CONTROL HAVING FEEL-BACK

Filed July 7, 1960 2 Sheets-Sheet 1

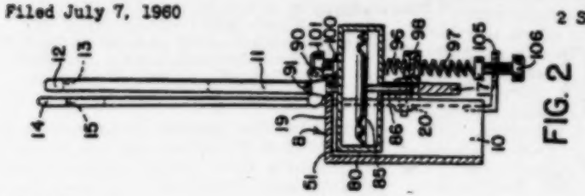

FIG. 2

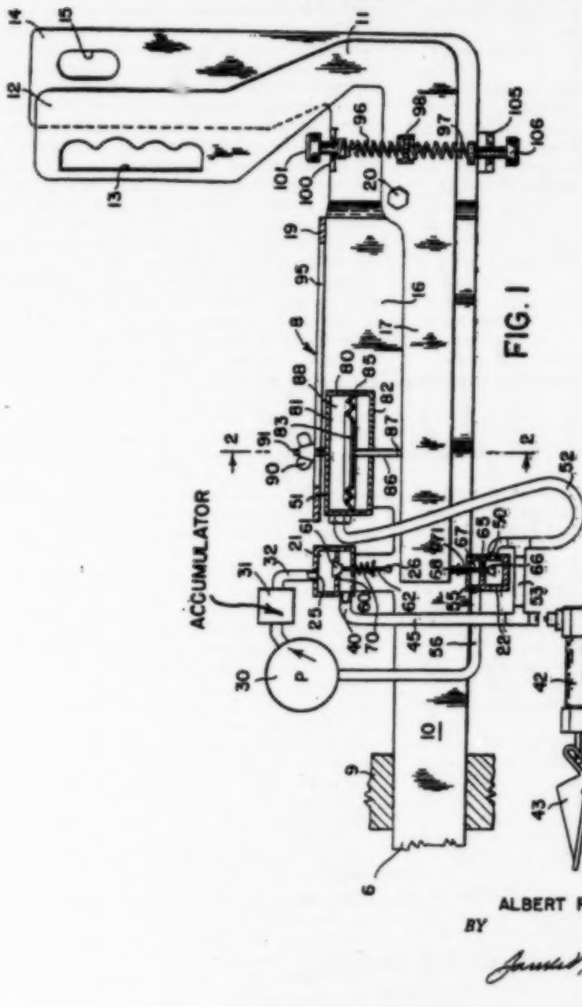


FIG. 1

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MANUALLY OPERATED HYDRAULIC ACTUATOR CONTROL HAVING FEEL-BACK

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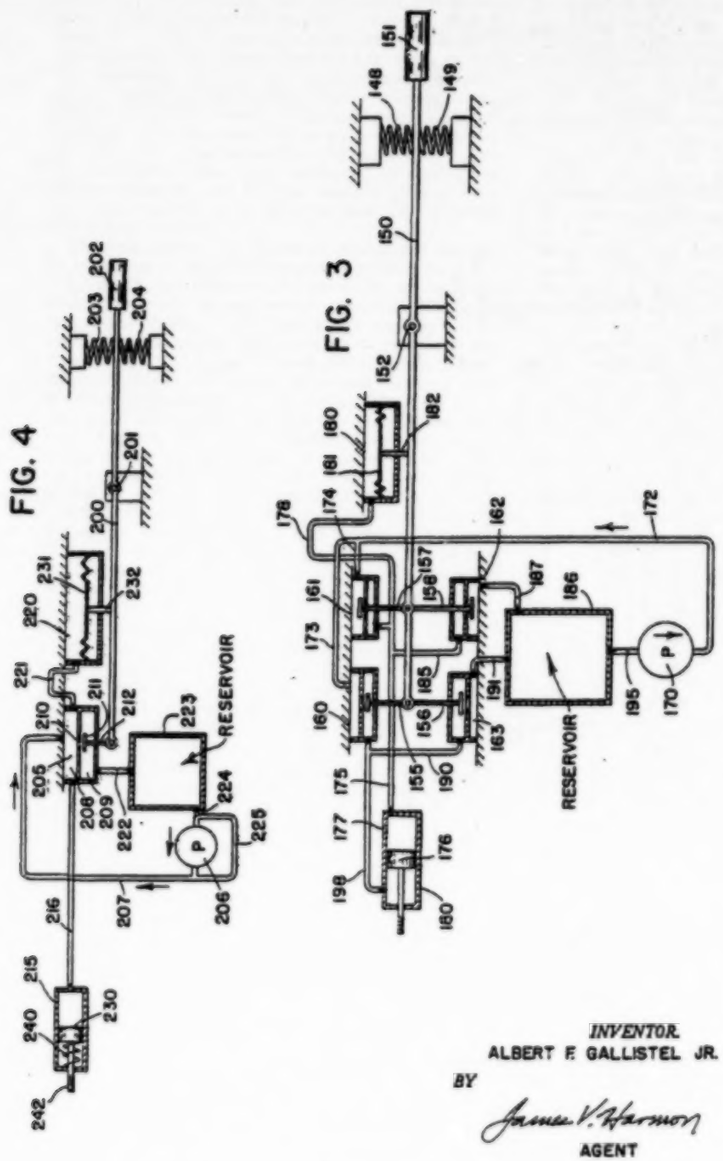


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3,168,203

# MANUALLY OPERATED HYDRAULIC ACTUATOR CONTROL HAVING FEEL-BACK

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12 Claims. (Cl. 214—1)

This invention relates to manually operated hydraulic actuator controls and more particularly to manually operated hydraulic actuator controls which provide for the operator a tactile sense of the pressure being exerted by the actuator, i.e. "feel back." While the device has general application, the invention is particularly useful in connection with the gripping tongs or jaws of remotely controlled manipulators or mechanical arms and the like. For illustrative purposes, the invention will be described in connection with remotely controlled manipulators.

In recent years, remote handling equipment has become an important phase of the atomic industry, among others. Included in such remote handling devices are crane hoists, underwater corrosion resistant manipulators, manned and unmanned mobile manipulators, fuel handling devices and mechanical arms. The mechanical arm is a remote control device which will duplicate all or part of the motions of the human arm and hand. These mechanical arms ordinarily include an upper arm member rotatably on a base and provided with drive motors for controlling the motions thereof. Pivotally mounted on the end of the upper arm and adapted to be moved about this pivot by suitable motors is a lower arm member. A pair of gripping tongs or jaws are provided at the free end of the lower arm. The jaws are opened and closed by a suitable remotely controlled actuator. The present invention provides an improved method for opening and closing such jaws with a provision for allowing the operator to obtain a tactile sense (feel-back) of the pressure being exerted against an object by the jaws. This allows the mechanical arm to be used for manipulating delicate glassware and very heavy articles with equal dexterity.

Previous practices in the field of remote handling and control embrace four main types. The first is the so-called "master-slave" control which utilize the strength of the operator through a system of pulleys, cables and levers. These devices can exert only the force the operator exerts less all the frictional effects which, because of the system's complexity, may be considerable and may vary appreciably from time to time. The second is power devices, i.e. electrically powered or hydraulically powered devices, which utilize a meter or sound system for measuring pressure exerted. These devices are satisfactory, but require extra attention, i.e. observation or listening, by the operator. The third type of device is the electrical servo system which utilizes an electromotive device such as a D.C. motor to resist the operator's grip. This sort of system has been used, among other places, in aircraft but is usually rather complicated and quite expensive. Furthermore, since the output device often operates in a stationary or stalled condition, these electrical devices often tend to overheat. The present invention, in contrast, can operate in a stalled condition indefinitely, yet has no tendency to overheat, and is cheaper and easier to manufacture than these electrical devices. Still another type of device utilizes a direct mechanical linkage to the output device but is provided with a power assist mechanism coupled to the linkage to increase the power output. This type of system is, however, limited in its application since the output device cannot be moved from place to place with respect to the control device because of the direct mechanical linkage. The present invention is more satisfactory in this respect since flexible hydraulic hoses may



be used which allow the manipulator to be moved in all directions with respect to the remotely placed control. A further disadvantage of previous devices is the inability to quickly and conveniently change the ratio between the pressure exerted by the output actuator and the tactile pressure detected by the operator.

It is therefore one object of this invention to provide an improved manually operated hydraulic actuator control which provides for the operator a tactile sense of pressure being exerted by the actuator.

It is another object of the present invention to provide an improved manually operated actuator control with feel-back which can exert a pressure of many times the strength of the human hand and in which the output device or actuator can be moved from place to place as desired.

It is still another object of the present invention to provide a manually operated actuator control having a provision for quickly and conveniently changing the ratio between the force exerted by the output device or actuator and the force exerted by the operator.

It is still another object of the present invention to provide a manually operated actuator control which will exert an output force which may be changed from greatly in excess of the pressure exerted by the operator's hand to only a small fraction of the force exerted by the operator's hand and still allow the operator to feel the pressure exerted regardless of the amount of the unexpected counterforce exerted by an object against the output actuator.

It is a still further object of the present invention to provide an improved manually operated actuator control having the ability to be maintained in a stalled condition for an indefinite period of time but yet which does not tend to overheat during the time it is maintained in a stalled position.

It is still a further object of this invention to provide an improved manually operated jaw control wherein the operation of the device may be changed as desired from a condition wherein the jaw grip is released when the operator relaxed his grip on the control element to a condition in which the jaws maintain their grip when the operator relaxed his grip.

It is still a further object of this invention to provide an improved manually operated actuator control in which the output actuator will lock in position when no pressure is being exerted on the control element.

Other objects and advantages will become apparent in the following specification and in the appended claims in which:

FIGURE 1 is a side elevation partly in section showing one form of the present invention;

FIGURE 2 is a transverse sectional view taken along lines 2—2 of FIGURE 1;

FIGURE 3 is a schematic diagram of another form of the present invention;

FIGURE 4 is a schematic diagram of still another form of the invention.

In FIGURE 1 there is shown a manually operated hydraulic actuator control 8 having feel-back according to the present invention which may be used in remotely controlled manipulating devices such as mechanical arms and the like. The embodiment illustrated in FIGURE 1 is used only in operating the gripping tongs 43 but it is apparent that like systems may be used to operate other motions of the mechanical arm such as rotation of the gripping mechanism, or extension of the arm.

The control device 8 is movably mounted on a fixed base 9. Motion of the extension 6 of control device 8 with respect to base 9 may be used to control other actuators (not shown) if desired such as those used for rotation or extension of the tongs or jaws 43. Extending

from base 9 is a frame member 10. Pivotally mounted on frame member 10 is a valve control element or lever 11 which may turn about a suitable pivot bolt 20. Control lever 11 is provided with an upwardly extending gripping portion 12 and a horizontally extending portion 17, and frame member 10 is provided with a horizontally extending support portion 16 and an upwardly extending portion 14. Frame member 10 is provided with a horizontally disposed portion 19 to support a pressure sensing means such as feel-back actuator 51 as described more fully herein below. At the upper end of control lever 11 there is provided a hand grip opening 13 and in the upper end of frame member 10 there is provided a thumb opening 15.

Between the pivot 20 and the base 9, there are provided two hydraulic fluid control valves 21 and 22, both such valves being secured to the control frame 10. Valve 21 is located above the end of control lever 11 and valve 22 is located below the end of control lever 11. Valve 21 includes an inlet opening 25 which communicates with a source of fluid pressure such as hydraulic fluid pump 30 through accumulator 31 and fluid line or conduit 32 and an outlet 40 which communicates with output actuator 42 through line or conduit 45 and to the feel-back actuator 51 through lines 52 and 53. Valve 22 includes an inlet opening 50 which communicates with feel-back actuator 51 and actuator 42 through hydraulic fluid lines 52 and 53 respectively. Outlet port 55 communicates with the pump 30 through line 56. Valve 21 is provided with a valve port 60 therein which may be opened and closed by means of valve 61. Valve stem 62 extends downwardly from valve 61 through the casing of valve 21 and the lower end thereof designated 26 is operatively associated with the upper portion of the end of valve control lever 11. Valve 22 contains a valve port 65 and a valve 66 to open and close the port 65. Extending upwardly from valve 66 and out through the casing of valve 22 is a valve stem 67, the upper end thereof designated 68 being operatively associated with the lower end portion of valve control lever 11. Thus when the grip openings 13 and 15 of control lever 11 and frame member 10 respectively are grasped manually and brought together, the free end of valve lever 11 moves upward contacting the lower end 26 of valve stem 62 causing valve 61 to open port 60 allowing the fluid to pass through the valve 21 from duct 32 to duct 45. Likewise when the hand grip on the control lever 12 and the upper portion 14 of control lever frame 10 is released, the free end of valve lever 11 will be caused to lower causing valve 21 to close and depressing the valve 66 by contact of the lower surface of valve lever 11 with the upper portion 68 of valve stem 67 causing valve 66 to open port 65 and allowing fluid to return from ducts 52 and 53 through duct 56 to the pump 30. While valves 61 and 66 may be seated by means of hydraulic pressure within the hydraulic system, they are preferably held in the normally seated position by means of suitable springs designated 70 and 71 respectively. Valve springs 70 and 71 should not be strong enough so that the pressure exerted will be felt to any appreciable extent by the operator.

The pressure sensing means or feel-back actuator 51 comprises a cylindrical casing 80 provided with a top wall 81 and bottom wall 82. Disposed transversely therein is a movable element such as flexible diaphragm 83 attached securely to the casing 80 along its circumference 85. A number of concentric bends are provided in a diaphragm 83 to allow the diaphragm to move up or down when hydraulic fluid is introduced into chamber 88 above the diaphragm. Connected to the bottom of diaphragm 83 and extending downwardly out through the bottom of the bottom wall 82 of feel-back actuator 51 there is a feel-back output member 86. The lower end 87 of member 86 is adapted to contact the upper surface of the horizontal portion of the control lever 11. The feel-back actuator 51 is attached to the horizontally extending portion 19 of frame member 10 by means of a wing nut



designated 90 which is screwed onto threaded stud 91 extending upwardly from the top of feel-back actuator 51 through slot 95. By loosening wing nut 90, the feel-back actuator 51 may be moved laterally to any desired position parallel to the horizontally extending portion of valve control lever 11 for purposes described herein below.

A short distance to the right of pivot 20 there are provided two centering springs designated 96 and 97. Spring 96 is disposed vertically above control lever 11 and the spring 97 is disposed vertically below control lever 11. The lower end of spring 96 and the upper end of spring 97 are attached to a suitable mounting bracket 98 extending outwardly from the side of control lever 11. Extending laterally from the top of the frame member 10 is a spring adjustment screw bracket 100 having an adjustment screw 101 screw threaded therein. The lower end of adjustment screw 101 is attached to the upper end of spring 96. Extending laterally from the bottom of control lever frame 10 is a spring adjustment screw bracket 105 having an adjustment screw 106 screw threaded therein. The upper end of adjustment screw 106 is attached to the lower end of spring 97. By tightening screw 101, spring 96 is compressed and the free end of the control lever 11 is biased toward opening valve 21 while tightening screw 106 will compress spring 97 and bias the control lever 11 toward opening valve 22.

The operation of the device will now be explained. The remotely located tongs 43 are opened and closed by a conventional fluid operable output actuator cylinder 42 by manually squeezing together and releasing the gripping portions 12 and 14 of control lever 11 and valve frame member 10 respectively. When the gripping portions 12 and 14 are squeezed together, the valve 21 will be opened and valve 22 will be closed causing fluid to pass into actuator cylinder 42 so that the tongs close. When the gripping portions 12 and 14 are made to separate, the free end of control lever 11 will be depressed opening valve 22 and closing valve 21, thereby withdrawing fluid from output actuator 42 and thus opening the tongs or jaws 43. When the gripping portions 12 and 14 are in an intermediate position, both valves 21 and 22 will be closed. In this condition fluid will not be able to pass either into or out of the output actuator 42. Thus, the tongs are locked in position and will neither open nor close.

The feel-back or tactile sense of the pressure being exerted by the tongs is provided by the feel-back actuator 51 which communicates with the outlet port of valve 21 through lines 52, 53 and 45 and with the inlet of valve 22 through line 52 so that when valve 21 is opened the pressure exerted by the fluid on output actuator 42 is also exerted on the top of diaphragm 83. Thus, when the gripping tongs 43 close on an object, the resistance set up by the object causes the fluid pressure in the actuator 42 to increase. The increased fluid pressure is exerted through lines 53 and 52 to chamber 88 causing diaphragm 83 and the rod 86 to exert a downward force against the top surface of the control lever 11. This force tends to separate the gripping portions 12 and 14 and can be detected by the operator as a sense of pressure proportional to the pressure exerted by the tongs against the object. Thus, when the tongs close without meeting any resistance, no outward pressure will be exerted by the gripping members 12 and 14. It should also be noted that the pressure exerted by the tongs 43 will always be proportioned to the pressure exerted by the diaphragm 83 against control lever 11. By using a suitable ratio of tong actuator area to feel-back diaphragm area, and making due allowance for any mechanical leverage in the device, the tongs may be made to grip with almost exactly the same force as applied by the operator in squeezing the control handle.

The invention has a further provision for allowing the tongs to perform duties requiring more than the strength in a man's hand. This provision consists of means for







adjusting the effective point of application of force from said feel-back actuator to said control lever. If it is desired to grip with a greater amount of force, the feel-back actuator 51 may be moved to selected positions substantially parallel with the longitudinal axis of portion 17 of lever 11 by loosening wing nut 90. As a result, the ratio of the force exerted against the operator's grip with respect to the force exerted by the gripping tongs 43 may be varied. Thus, if the feel-back actuator 51 is moved closer to the pivot point 20, the gripping tongs 43 will exert an increased force in comparison to the force exerted by the operator's hand. Conversely, if the feel-back actuator 51 is moved away from the pivot 20, the pressure exerted by the gripping tong 43 will be reduced in comparison to the force exerted by the operator's hand. Thus, the provisions for changing the position of the feel-back actuator 51 allows the force exerted by the tongs 43 to be the same as the pressure exerted by the operator, or many times the force exerted by the operator or only a fraction of the pressure exerted by the operator.

The biasing springs 96 and 97 can be biased either toward opening or closing the valve 21. Thus, if adjustment screw 101 is tightened, spring 96 will be compressed and the horizontally extending portion 17 of the control lever 11 will be raised causing valve 21 to open, thus maintaining the hydraulic gripping tongs in a normally closed position. If screw 101 is loosened and the adjustment screw 106 is tightened, a greater amount of pressure will be exerted by spring 97 and the control lever 17 will be depressed causing valve 21 to close and valve 22 to open allowing suction from pump 30 to withdraw fluid from lines 56, 52 and 53 thereby maintaining the tongs 43 in a normally opened position. Maintaining the tongs 43 in a normally opened position is the preferred operating condition for the invention.

In FIGURE 3 there is shown another embodiment of the invention including a horizontally extending control lever 150 having a control handle 151 at the right side thereof. Lever 150 is pivotally mounted on pivot 152. To center the control lever 150, there are provided two springs designated 148 and 149 attached to lever 150 between pivot 152 and handle 151. These springs operate similarly to centering springs 96 and 97 described above in connection with the embodiment illustrated in FIGS. 1 and 2. Attached to the left side of control lever 150 there are four poppet valves 155, 156, 157 and 158, each of which is pivotally connected to the control lever 150 and constitute the movable elements of fluid valves 160, 163, 161 and 162 respectively. When valve control lever handle 151 is raised, valves 160 and 162 will be open while the valves 161 and 163 will be closed. Conversely, when the control lever is lowered, valves 161 and 163 will be open and valves 160 and 162 will be closed. A pump 170 transfers fluid to valves 160 and 161 through line 172. The pair of valves designated 161 and 162 and the pair of valves 160 and 163 are connected in series between the outlet and inlet of pump 170, each pair being in parallel with respect to the other pair. Part of the fluid passing through line 172 is directed through line 173 to valve 160 and a part is directed through line 174 to valve 161. If valve 161 is open, the fluid passing out of valve 161 runs through line 175 to actuator 177 at the right of a movable element such as piston 176 and through line 178 to the upper chamber of the feel-back actuator 180 which is similar in construction to the feel-back actuator of the embodiment illustrated in FIGURES 1 and 2. A flexible diaphragm 181 within actuator 180 has connected to it a downwardly extending actuator rod 182 which passes out through the bottom of the actuator casing and rests against the top surface of the control lever 150 to provide feel-back to the operator in a manner similar to that described in connection with FIGURES 1 and 2. Conversely, if valve 160 is open, the fluid passing out of valve 160 runs through line 198 to actuator 177 so as to cause piston 176 to move to the right. The inlet port of valve 162 is connected to the outlet port of valve 161 by fluid line 185 and the outlet of valve 162 is connected to the reservoir tank 186 by means of fluid line 187. The inlet of valve 163 is connected to the outlet of valve 160 by means of line 190 and the outlet of valve 163 is connected to the reservoir 186 by means of line 191. The outlet of the reservoir 186 is connected to the pump 170 by means of line 195. The outlet of valve 160 is connected to actuator 177 at the left side of piston 176 by means of line 198.



To move piston 176 to the left, control lever 151 is lowered causing valves 160 and 162 to be closed and valves 161 and 163 to be open. Fluid will then pass from the pump through lines 172 and 174 into valve 161 and through line 175 into actuator 177 and through line 178 into feel-back actuator 180. The pressure of fluid to the right of piston 176 drives the piston to the left and forces fluid to the left of piston 176 through line 198 and because valve 160 is closed through line 190 then through valve 163 and finally into the reservoir 186. When the handle 151 is raised, valves 161 and 163 are closed and 160 and 162 are open, allowing fluid to pass from the pump through lines 172 and 173, through valve 160 and out through line 198 to the left side of piston 176. Fluid pressure on the left side of piston 176 drives the piston 176 to the right causing fluid to move from the actuator 177 through line 175 then through line 185, next through valve 162 and finally through line 187 to the reservoir 186. By means of the apparatus described, a positive pressure is exerted upon the right side of piston 176 when the control handle 151 is lowered, and when the handle 151 is raised, positive pressure is produced on the left side of piston 176. The advantage of the system illustrated in FIGURE 3 is that a positive pressure can be used to drive the piston 176 in either direction, thus assuring positive action of piston 176 when it is moving either to the left or to the right. Suction on the inlet side of the pump does not have to be relied upon to move the piston 176 back to its starting position. The feel-back actuator 180 operates in a manner similar to that illustrated in FIGURES 1 and 2 so that when the piston 176 begins to move to the left and encounters an object, the resistance causes fluid pressure to be built up in lines 175 and 178 and in the upper compartment of the diaphragm chamber 180 causing diaphragm 181 to move downward and exert a force against the upper surface of lever 150 thereby allowing the operator to sense a pressure proportional to the resistance met by the piston 176.

As in the embodiment illustrated in FIGURES 1 and 2, the feel-back actuator 180 may be moved to the left and right substantially parallel to the axis of control lever 150 in order to increase or decrease the feel-back sensitivity as desired.

Referring now to FIGURE 4, there is shown still another embodiment of the invention including a horizontally disposed control lever 200 pivotally mounted on pivot 201 and movable manually up and down about pivot 201 by means of control lever handle 202. To center the control lever handle 200, there are provided between handle 202 and pivot 201, two springs 203 and 204 which may be biased towards the valve open position or towards the valve closed position as described in connection with FIGURES 1 and 2. Located above the left end of control lever handle 200 is a valve 205 having an inlet connected to the outlet of pump 206 by fluid line 207. The valve 205 is divided into an upper compartment 208 and lower compartment 209 separated by means of a wall having a valve port 210 in the center thereof. Port 210 may be opened and closed by means of poppet valve 211, the stem 212 of which is pivotally connected to the left end of valve control lever 200. When the left end of valve control lever 200 is raised, port 210 will be closed and when lowered, port 210 will be opened. Connected between valve compartment 208 and actuator 215, there is provided a fluid line 216 and connected between valve chamber 208 and

the feel-back actuator 220 is a fluid line 221. When the valve is open, fluid from the pump 206 passes through port 210 into chamber 209, passes out of the valve through line 222 into reservoir 223 and back to pump 206 through line 224. A by-pass line 225 may be provided and designed in order to limit the pressure exerted by pump 206.

When the pump is in operation and port 210 is opened, fluid will pass through line 207, into valve 205, through port 210, into chamber 209, through line 222, through the reservoir 223 and back to the pump 206. Since the flow is unrestricted through the valve and reservoir only a small amount of pressure will be built up in the hydraulic actuator 215 and in the feel-back actuator 220. When, however, the handle 202 is lowered manually causing lever 200 to turn about pivot 201, poppet valve 211 will be raised, closing port 210 so that the passage of fluid into the reservoir tank through line 222 is interrupted. As a result, pressurized fluid will pass outwardly in line 216 and 221 causing the piston 230 to travel to the left and causing the diaphragm 231 and diaphragm lever 232 of the feel-back actuator 220 to be lowered. The pressure of diaphragm lever 232 against the upper surface of control lever 200 resists the downward pressure on handle 202 exerted by the operator when the actuator piston 230 meets a resistance as described above in connection with the other embodiments. A lightweight spring 240 is used to return the piston 230 to the right when valve 205 is again opened. Connecting rod 242 extending out of the casing of actuator 215 may be used to position any desired object.

Other forms of valves may be used in place of the poppet valve as illustrated. For example, a conventional spool valve may be used. If a spool valve were used, in the FIGS. 1, 2 modification, it could be pivotally connected to the free end of the horizontal extension 17 of control lever 11 and would still provide a locking action when the lever control handle is in an intermediate position. Furthermore, such a spool valve would require no springs such as springs 70 and 71.

While the feel-back device has been illustrated as a flexible diaphragm mounted in a cylindrical compartment, other types of hydraulic output devices or actuators could be used such as a conventional cylinder and piston type actuator.

Relatively small valves are preferred in the embodiments illustrated in FIGURES 1 through 4 in order to make the force exerted by the valve on the control lever arm negligible. In the embodiment illustrated in FIGURE 4, the valve 211 may be made relatively large in size and the valve head of valve 211 correspondingly larger in area so that the fluid pressure in chamber 208 of valve 205 would then exert a substantial force against the top of valve 211 when the valve was closed to provide feel-back to the operator. In the event that this modification were made, it will be apparent that the feel-back diaphragm device 220 could be eliminated. In this modification, the valve 205 should be movable with respect to the lever arm 200 when variations in sensitivity of feel-back are desired.

The embodiment illustrated in FIGURES 1 and 2 will normally be preferred because it has an advantage that the valves handle only the amount of fluid displaced by the cylinder 42 while the valves of the embodiment illustrated in FIGURE 4 must handle the entire displacement of the pump. The embodiment illustrated in FIGURE 3 is preferred where it is desired to provide a positive pressure on both sides of the actuator piston. The embodiment illustrated in FIGURE 4 will be preferred where simplicity is important but the piston 230 will have to be retracted by means of a spring or the like and cannot rely upon the negative pressure exerted at the pump intake as in the embodiment illustrated in FIGURE 1.

From the foregoing discussion, it will be apparent that the invention provides a novel and reliable means for



operating actuators. It is especially valuable in remote controlled manipulators to provide a tactile sense for the operator of the pressure being exerted by the actuator on the object handled. The invention includes provision for simply and quickly changing the ratio of the force exerted by the operator and by the output actuator so that the output actuator may exert many times the strength of a man's hand or if desired the ratio may be changed so that the operator feels a fairly large force while the actuator exerts only a small force. It also includes a provision for allowing the tongs to remain normally open, normally closed or for locking the tongs in a gripping position when the operator releases his grip whichever is desired.

In view of the principles set forth herein, I have shown some of the ways of carrying out the present invention and some of the equivalents suggested by these disclosures.

Now, therefore, I claim:

1. A remotely controlled manipulator device including a hand mechanism for performing gripping motions, said hand mechanism having a pair of relatively movable gripping members, first pressure responsive actuator means for effecting gripping movement of said gripping members, means for operating said output actuator including a source of pressure, conduit means connecting said actuator to the pressure source, valve means for permitting the flow of a fluid medium from the pressure source to the actuator, said valve means also adapted to prevent the flow of said fluid medium to said actuator, lever means for opening and closing said valve means by direct contact with said valve means, second pressure responsive actuator means providing manual sensing of the magnitude of the gripping force being exerted by the gripping members on an object, said second pressure responsive actuator means operatively connected between the valve means and the first actuator means, said second actuator means provided with an output member which directly contacts the lever means and exerts a force against said lever means, and means for varying the effective relative position of said second pressure responsive actuator means with respect to the lever means whereby the ratio of the force exerted by the gripping members with respect to the force exerted by the operator of the manipulator may be varied.

2. In a remotely controlled manipulator system a hand mechanism for performing gripping motions, said mechanism having a pair of relatively movable gripping members, an actuator for effecting gripping movement of said gripping members, a source of fluid pressure, means for operatively connecting said actuator to said source, valve means for controlling the flow of a fluid medium from said source to said actuator, means for opening and closing said valve means by direct contact with said valve means, the improved combination comprising pressure responsive sensing means operatively connected to the valve opening and closing means and the gripping members whereby the pressure exerted by said gripping members on an object can be manually sensed.

3. The combination of claim 1 wherein the lever means for operating the valve means includes an elongated member pivotally connected to a base member, a first end of said member having a handle thereon for manual control, the second end of said member adapted to engage the valve means so as to actuate said valve means in response to pivotal movement of said lever relative to the base member.

4. The combination of claim 1 wherein the lever means includes an L-shaped member which includes a horizontal leg and a vertical leg, said vertical leg including means for manually gripping said leg, a base member, means for pivotally connecting said L-shaped member to the base member, and biasing means for orienting said L-shaped member in a desired relative position.

5. The combination of claim 3 wherein the second







pressure responsive actuator means includes a feel-back actuator responsive to fluid pressure, the output member forming a part of said actuator, means for mounting said feel-back actuator so that said output member contacts a portion of the elongated member, and conduit means for operatively connecting said actuator to the output actuator.

6. A remotely controlled manipulator device including a hand mechanism for performing gripping motions, said hand mechanism having a pair of relatively movable gripping members, a pressure responsive output actuator for effecting gripping movement of said gripping members, means for operating said actuator means including a source of pressure, at least two control valves for controlling the flow of a fluid medium from said source of pressure, means for operating said control valves independently of each other, said valve operating means including an elongated lever pivotally connected at a point between its two ends to a base member, one end of said lever being positioned between said control valves and adapted to engage at least one of said valves in response to pivotal movement of said lever relative to the base member, pressure responsive means providing manual sensing of the magnitude of the gripping force being exerted by the gripping members on an object, said pressure responsive means operatively connected between the pair of control valves and the output actuator, and means for mounting said pressure responsive means relative to the base member so that it contacts a portion of the lever.

7. The combination of claim 6 wherein the pressure responsive means includes a feel-back actuator responsive to fluid pressure, said actuator having an orifice, a relatively movable output member which contacts a portion of the pivotal lever and which exerts pressure on said lever when the output actuator meets resistance to motion, and a variable volume chamber between said orifice and said output member.

8. The combination of claim 7 wherein the variable volume chamber is formed by the sides of the actuator, one end of said actuator, and a flexible diaphragm located within the actuator between the orifice and the output member.

9. A remotely controlled manipulator device including a hand mechanism for performing gripping motions, said hand mechanism having a pair of relatively movable gripping members, a first pressure responsive actuator for effective movement of said gripping members, an actuator control comprising a source of pressure, means for controlling the flow of a fluid medium from said pressure source, said means including a first control valve and a second control valve, a control lever for opening and closing said first and second valves, a second pressure responsive actuator to provide feel-back, said second actuator operatively connected to the first actuator by conduit means, said second actuator provided with an output member which is adapted to contact a portion of said control lever and exert pressure on said lever when the first actuator meets resistance to motion, thus permitting manual sensing of the magnitude of gripping force being exerted by the gripping member on an object.

10. A remotely controlled manipulator device including a hand mechanism for performing gripping motions, said hand mechanism having a pair of relatively movable gripping members, a first fluid pressure responsive actuator for effecting gripping movement of said gripping members, means for operating said first actuator including a source of fluid pressure having an inlet and an outlet, means for controlling the flow of fluid from the pressure source, said means including a first flow control valve and a second flow control valve connected in series between the outlet and the inlet of said pressure source, lever means for opening and closing said first and



second control valves, said lever means being so arranged that opening of one of said valves closes the other of said valves, and a second fluid pressure responsive actuator operatively connected to the first actuator, said second actuator contacting a portion of the lever means to exert pressure against said lever means proportional to fluid pressure within the first actuator, said second actuator connected between the means for controlling the flow of fluid from the pressure source and the first actuator.

11. A remotely controlled manipulator device including a hand mechanism for performing gripping motions, said hand mechanism having a pair of relatively movable gripping members, a first fluid pressure responsive actuator for effecting movement of said gripping members, means for operating said first actuator including a source of fluid pressure having an inlet and an outlet, means for controlling the flow of fluid from the pressure source, said means including a control valve, lever means for opening and closing said control valve, said lever means pivotally connected at a point between its two ends to a base member, one end of said lever means adapted to engage the control valve in response to pivotal movement of said lever means relative to the base member so as to open and close said control valve, and a second fluid pressure responsive actuator operatively connected to the first actuator, said second actuator contacting a portion of the lever means to exert pressure against said lever means proportional to fluid pressure within the first actuator, said second actuator connected between the means for controlling the flow of fluid from the pressure source and the first actuator.

12. A remotely controlled manipulator device including a hand mechanism for performing gripping motions, said hand mechanism having a pair of relatively movable gripping members, a first fluid responsive actuator for effecting movement of said gripping members, means for operating said first actuator including a source of fluid pressure having an inlet and outlet, means for controlling the flow of fluid from the pressure source, said means including a first pair of control valves connected in series between the outlet and the inlet of said pressure source and a second pair of control valves connected in series between the outlet and the inlet of the said pressure source, said first pair of control valves connected in parallel with respect to said second pair, lever means for opening and closing said valves, said valves being so arranged that one valve of each pair will be open when the other valve of that pair is closed, conduit means connecting said first pair to the first actuator, conduit means connecting said second pair to the first actuator, and a second fluid pressure responsive actuator operatively connected to the first actuator, said second actuator contacting a portion of the lever means to exert pressure against said lever means proportional to fluid pressure within the first actuator, said second actuator connected between the means for controlling the flow of fluid from the pressure source and the first actuator.


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July 2, 1968 L B TAYLOR 3,390,580

SAMPLE SYSTEMS

Filed Jan. 24, 1966 2 Sheets-Sheet 1

Fig.1

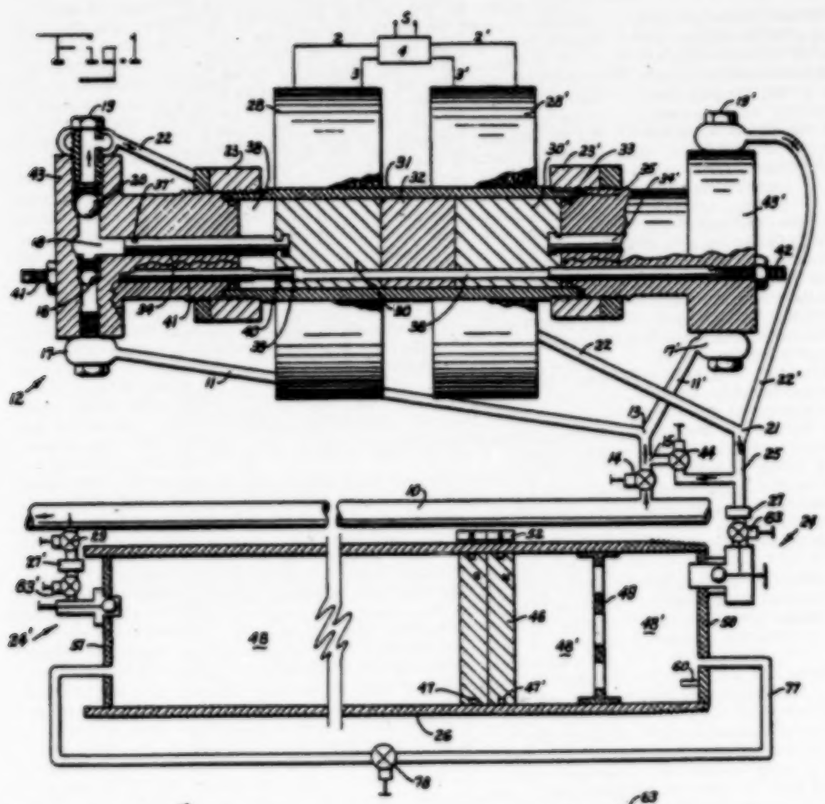


Fig.2

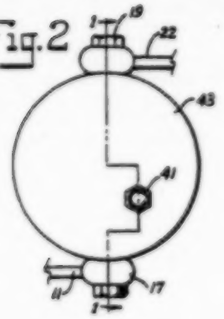
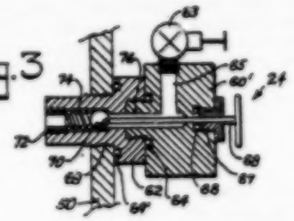


Fig.3



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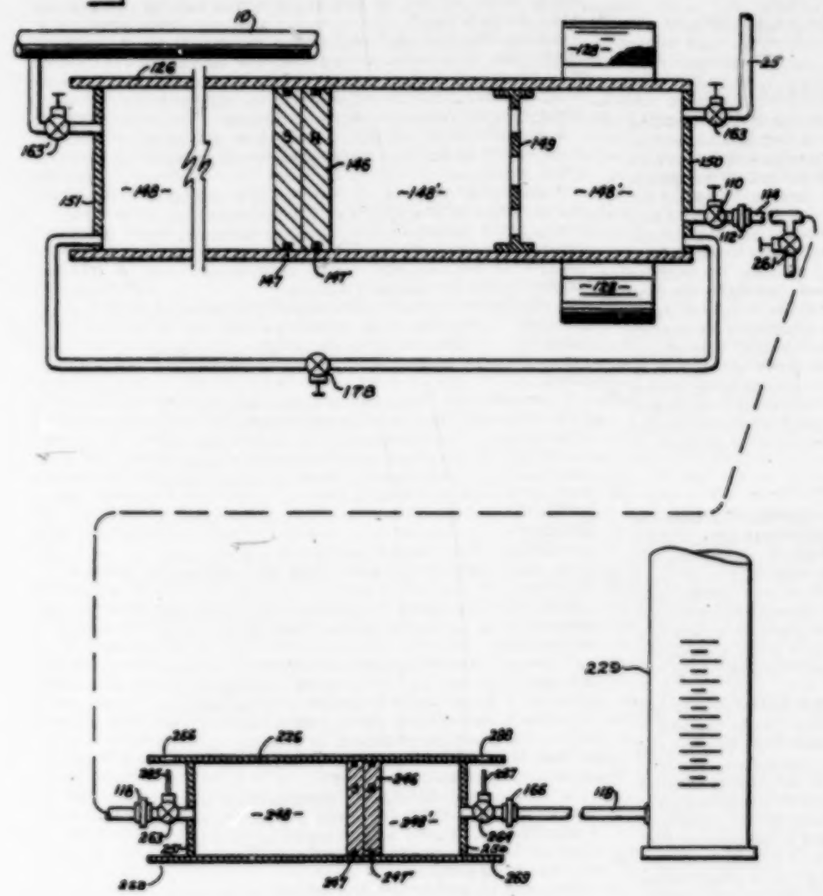
SAMPLE SYSTEMS

Filed Jan. 24, 1966 2 Sheets-Sheet 2

Fig.4



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SAMPLE SYSTEMS
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ABSTRACT OF THE DISCLOSURE

A sampling system for withdrawing fluid samples from a conduit consisting of a double acting solenoid operated pump and a flask for storing the fluids sampled. In addition another smaller flask may be utilized for transporting the sampled fluid to an analysis location. The pump features two solenoids, one for moving the armature in each direction the armature being provided with two suitably located magnets. The two pump pistons extend beyond the armature into the two pump cylinders. The receiving flask is constructed of nonmagnetic material in the form of a cylinder closed at both ends save for suitable filling and emptying ports. A magnetized piston in the cylinder separates the sampled material from that there before. The magnetic properties of the piston are utilized to either provide an indication of its position or for driving it to one end of the cylinder or the other. A perforated piston can likewise be moved magnetically for stirring purposes. The second flask is similar in construction to the first but is smaller.

This invention relates to an apparatus for sampling fluids and pertains more particularly to an apparatus for automatically collecting, over a predetermined time period, a continuous composite or average fluid sample from a pipe line or the like. The time interval between each integral of sample, as well as the quantity of the sample, may be set at a predetermined rate to provide a composite sample of the flowing stream so as to enable a laboratory determination of the quality and composition of the sampled fluid.

Another aspect of this invention relates to a sample receiver with a novel mixing device that is arranged in conjunction with the sample receiver that will overcome any possible settling out of heavy components. The mixing device is magnetically actuated through external means so as to enable the laboratory to withdraw a small quantity of sample from the receiver that is accordingly representative of the entire contents of the sampled fluid contained within the receiver. The novel receiver further provides a unique magnetic indicating means that enables one to determine the fluid content level of the receiver when the sample being taken is a liquid.

This invention further provides a novel sampling method that embraces the steps of collecting a predetermined number of integral sample portions over a predetermined interval of time and subsequently transferring a portion of the sample into a smaller size flask for laboratory analysis.

Also of importance is the provision of a novel valve arrangement used in conjunction with the receiver that enables one to readily charge or withdraw a sample from the container with a minimum of effort while avoiding contamination.

It is accordingly an object of this invention to provide a novel pump such as before mentioned that will move a predetermined amount of fluid during a predetermined time cycle.

Another object of this invention is to provide a novel sample receiver that precludes purging prior to sampling.

Another object of this invention is to provide a novel means of determining the fluid contents of the novel sample receiver.

Another object of this invention is to provide a novel mixing device that may be used in conjunction with the novel sample receiver.

Another object of this invention is to provide a novel combination of a pump, receiver flask, and laboratory flask arranged in a novel manner that permits a predetermined amount of metered sample to be rapidly obtained from the system for laboratory analysis.

Still another object of this invention is to provide a novel method of obtaining a representative sample from a fluid system.

A still further object of this invention is to provide a unique method of sampling that includes transferring a predetermined amount of fluid sample at predetermined time intervals into a main sample receiver that may subsequently deliver a uniform portion of the sample to a smaller receiver for laboratory analysis.

A still further object of this invention is to provide a novel valve arrangement in conjunction with the receiver that simplifies obtaining the sample and enables rapid withdrawal of portions of the sample from the receiver.

These and other objects of the instant invention will become apparent from the following description of the invention taken in conjunction with the drawing, wherein:

FIGURE 1 is a diagrammatic view, partly in section, of one embodiment of the sample receiver and pump means, taken along line 1—1 of FIGURE 2.

FIGURE 2 shows an end view of the pump means of FIGURE 1.

FIGURE 3 is an enlarged sectional view of the novel valve means used in conjunction with the receiver of FIGURE 1.

FIGURE 4 is a partly diagrammatic view with some parts shown in section, of another embodiment of the sample system.

In general, the drawing shows in FIGURE 1 a pump indicated by numeral 12. The pump 12 is operatively attached to a system which is desired to be sampled, as for example, fluid carrying pipe line 10 at valve 14. The pump 12 is preferably connected to a sample receiver or flask 26 by inlet valve arrangement 24, and to the pipe line by the return purge valve 29.

Referring now in detail to the drawings, there is seen connected to valve 14 of pipe line 10 a conduit having a T-connection 15 followed by a Y-connection 13 that delivers the fluid sample into inlet connectons 17 and 17' of double acting pump 12.

The pump 12 is comprised of a central motor portion including a cylindrical housing 31 that carries solenoid coils 28, 28' peripherally thereabout and an armature made up of iron slugs 30, 30' and non-ferrous slug 32. Couplings 23 and 23' threadedly attach each end of housing 31 to the pump heads 43 and 43', which in turn contain the valves and pistons that move the sampled fluid.

A hollow bolt and connection 17 is connected to conduit 11 which is attached to the Y-connection 13 and communicates with pumping cavity 18 through the inlet check valve 16 located in the pumping cavity 18. The piston 34 is reciprocatingly received in close tolerance relationship within pumping cavity 18 and provides a pumping action as it reciprocates within the chamber since inlet valve 16 and outlet valve 20 are one way check valves that permit one way flow through the pump heads 43. A hollow nut 19 leads into outlet connection at conduit 22 which is essentially identical to the similar nut at fluid connection 17 except for being larger in diameter to permit assembly of the two check valves. Conduit 22 joins conduit 22' in a Y-connection indicated by number 21.

The motive power for piston 34 is provided by the before mentioned iron slugs 30 in conjunction with the non-ferrous portion 32 which jointly make up an armature comprised of elements 30, 32, and 30'. The armature is moved or actuated by solenoids 28 and 28' which are essentially a wire wound coil peripherally surrounding the non-magnetic cylinder 31. Energization of the solenoids at a predetermined time cycle will accordingly impart a movement to the armature to provide a pumping action having a cycle of operation that will coincide with that of the energization of the solenoids.

Control unit 4 provides the solenoids 28 and 28' with the above mentioned timed cycle or impulse of electrical energy. The control unit may be conveniently located in proximity to the pump 12 and provided with a source of current S. Conduits 2, 3, 2', and 3' electrically connect the solenoid coils to the control unit.

Rigidly attached to each armature slug 30 and 30' is the before mentioned pistons 34 and 34' which carries a grooved end portion to accommodate O-ring 37' to fluid seal the piston 34, pumping cavity 18, and void 38 from each other.

The void 38 is filled with fluid and communicates with a similar void in the opposite action or pump through adjustable passageway 36, to thereby provide for a cushioned stop which accordingly eliminates bumping or shock as would occur should the armature abut the main body or pump heads 43, 43' of the pump 12. This second void is not seen since the armature is at the extreme end of its travel or in abutting relationship with the pump head 43', hence this second void has been displaced or filled by the armature, as will be void 38 upon travel of the armature to the opposite extreme end of its stroke. Thus it is seen that the fluid contained within the voids is transferred from one void to the other with each stroke of the armature.

The size of the passageway 36 is controlled by reduced rod portion 40 which is adjustably mounted in the main pump head 43 by a threaded counter-bore that receives a like threaded rod portion 41 carrying a lock nut thereon. The passageway is drilled through as seen at 36 and may be provided with a larger counter-bore as at 39 to increase the rate of response of the armature and piston arrangement. The opposite pump head carries a similarly threaded adjusting rod 42 that extends up to or beyond the face of the armature and received in passageway 36. The rod 42 provides a second stop for the second slug 30'. Except for the construction of the already discussed rod 42, the remaining features of the pump head 43', are identical to the similar pump head 43, and accordingly will not be discussed in further detail.

Return conduits 22 and 22' are interconnected at Y-connection 21. A T-connection 25 provides a bypass back to T-connection 15 and located therebetween is a one-way check valve 44 that is resiliently biased to provide flow in the direction of the arrow. A quick disconnect comprised of union 27 connects the pump outlet to the sample reservoir or flask 26.

The sample flask comprises a cylindrical container 26 made of non-magnetic material and having a valved inlet at end 50 and a valved outlet at end 51. Grooved piston 46 carries O-ring 47 and 47' peripherally located thereabout and divides the flask into two sealed chambers 48 and 48'. The piston is adapted to slide from wall 50 to wall 51 as the chamber 48' is filled. The piston is magnetized so as to form a magnet having a polarity as indicated in the drawing. A stop 60 prevents damage to any portion of the valve 24 that may extend into the chamber 48'.

Located within sealed chamber 48' is a perforated plate 49 that is slidably received within the cylinder 26 and within chamber 48'. The plate is fabricated from magnetic material and may be caused to travel longitudinally between wall 50 and piston 46 upon application of an external magnetic field.

Conduit 77 is shown interconnecting each of the chambers 48 and 48' through a valve 78. This conduit and valve arrangement permits the piston to be moved from wall 51 to wall 50 in order to prepare the flask for a new sample while avoiding the necessity of discharging the old sample from the container. The piston is moved by an external magnetic force, such as a large solenoid coil placed peripherally about the flask, and moved from one extremity to the other while carrying the piston 46 along with the coil through magnetic attraction.

Located externally of the flask 26 is a magnet 52 mounted for longitudinal movement along the outside of the wall of the flask. The poles of magnet 52 are opposite in polarity to the piston 46 and hence the magnet 52 will tend to follow the piston thereby giving an indication of its position and hence the relative volume of the chambers. The magnet 52 may be located on a detachable track, or permanently mounted in a low friction grooved support extending longitudinally and adjacent the flask. The specific support means employed for the magnet are not shown in the drawing.

FIGURE 3 shows the details of the valve 24 that is located in each end wall 50, 51 of the flask. The valve arrangement is comprised of a ball-check valve 70 having a sealed stem 68 that upsets the ball from the seat when engaged therewith. The valve body 62 is threaded as at 69 and incorporates an O-ring seal 64' to provide a positive seal between the valve body and the flask. The valve body includes a threaded counter-bore that provides a chamber in which is housed the ball 70 and spring 74. The threaded keeper 72 maintains the spring in compression and forces the ball against its seat. Threadedly mounted in the body of the valve is a valve head 60' having drilled passageways 65 and 76 provided therein. Passageway 76 is counter-bored to receive the valve stem guide plug 67 and O-ring seal 66 which maintains the stem and plug in fluidtight relationship to the remainder of the valve parts. A conventional valve 63 may optionally be provided at the end of passageway 65 in order to maintain passageways 65 and 76 filled with sample fluid, if desired, thus eliminating the need for filling these passageways with mercury prior to withdrawing a portion of the sample for testing, as is known in the art.

Located in wall 51 of flask 26 is a second valve 24' identical to valve 24. A safety valve 63' attaches to a quick disconnect 27' which leads to sample return valve 29 in the main line 10.

Looking now to the embodiment of FIGURE 4, there is seen therein, a sample flask arrangement adapted to be used in lieu of the before described sample flask 26 of FIGURE 1. FIGURE 4 shows a safety valve 163 operatively connecting sample flask 126 to the Y-connection 25, which delivers fluid therethrough in accordance with the embodiment of FIGURE 1. Return valve 163' is operatively connected between the flask 126 and the pipe line 10. Valve 110 interconnects the laboratory flask 226 with the stationary sample flask 126. The stationary sample flask 126 is provided with magnetic piston 146 having a peripheral groove thereabout to receive O-rings 147 and 147' located therein in sealing relationship with the inside wall of the sample flask 126. The piston 146 divides the sample flask 126 into two chambers 148 and 148'.

Located within sealed chamber 148' is a perforated plate 149 that is slidably received within the cylinder 126 and within the chamber 148'. The plate is fabricated from magnetic material and may be caused to travel longitudinally between the wall 150 and the piston 146 upon application of external electrical current to the solenoid coil 128 located about the outer periphery of the sample flask 126. The relationship of the piston 146 and the perforated plate 149 to the sample flask 126 is identical with the relationship of these elements as was explained in conjunction with FIGURE 1.

The laboratory sample flask 226 is adapted to be connected to the stationary flask 126 by the quick disconnect 116. The laboratory sample flask is comprised of an elongated tubular vessel having recessed end plates 251 and 250 integrally attached to the sidewall 226 so as to provide tubular extensions 268, 269 in which is housed inlet and outlet valves 263 and 264 respectively, adjacent the end walls 250 and 251. The tubular extension is apertured as at 266 and 288 to provide access to the before mentioned valve stems by inserting a suitable valve stem handle therethrough. Each valve stem 265, 267 is preferably splined at the free end thereof in order to provide a means by which a valve stem handle or tool may be inserted through the apertures to thereby mate with the spline and accordingly actuate the valve between open and closed position. The valves 263 and 264 are suitably recessed within the tubular extension so as to protect the valve mechanism from damage or from inadvertently being opened after the sample has been taken.

Located within the laboratory flask 226 is a magnetically actuated piston 246 slidably received within laboratory flask 226 so as to be able to reciprocate from wall 250 to wall 251, in a manner as previously discussed in conjunction with the flask 26 and 126.

The grooved piston 246 receives O-ring 247, 247' about the periphery thereof to provide a sealed relationship between the piston and the flask wall.

The outlet valve 264 of the flask 226 is provided with quick disconnect 166 adapted to be connected to laboratory analyzing equipment.

A graduated vessel 229 may operatively be connected to the laboratory flask 226 by fluid conduit 118 when it is desired to obtain a specific sample size.

*Operation*

Referring to FIGURE 1, the pump and receiver are disclosed as being operatively attached to each other while taking a sample from pipe line 10. The sampled fluid flows through the main sample cut-off valve 14, past T-connection 15, to Y-connection 13 where the flow splits to provide each inlet connection 17 and 17' of the pump 12 with a fluid source. The fluid is forced into pumping cavity 18 through the hollow bolt at 17 and past one-way check valve 16 as it is moved by piston 34 past the outlet connection and hollow bolt at 19 into fluid conduit 22. The fluid entering the opposite pump head 43' at connection 17' follows the same type flow path since both pump heads are identical except for the control means 41 and 42. The fluid return lines 22 and 22' are brought together at Y-connection 21 where the fluid then flows to the sample flask 26 through T-connection 25, quick disconnect 27, safety valve 63, and check valve 24.

The rate of response of the pump piston 34 to the applied current of solenoids 28 is regulated by the adjustable orifice 39, 40 located in passageway 36. The response rate of the armature to the current applied to solenoids 28 and 28' is increased as the rod 40 is withdrawn from the counter-bore 39 which forms part of the orifice or adjustable passageway. The length of the pump stroke is controlled by adjustable rod 42 which provides a cushioned stop for the armature. As rod 42 is removed from its bore, the stroke of the pump is increased, and conversely, as the rod is extended into the pump head, the length of the stroke is decreased. Hence rods 41 and 42 provide a means by which both the rate of response and the length of the stroke of the piston may be adjusted to control the pumping time during a cycle as well as the integral sample size that is transferred from the pipe line 10 into the flask 26.

The rate at which the armature is actuated, or the number of strokes per minute made by the pump, is governed by control unit 4, which is adapted to energize the coils 28 and 28' with a signal that is sent through the electrical conduits 2, 2', 3, and 3'.



When the fluid sample first begins to enter flask 26, piston 46 and agitator 49 will be adjacent wall 50 in order to present the smallest possible void between the piston and wall, thus minimizing contamination. As the pump fills the flask with fluid, the piston 46 will move towards the opposite wall 51 as the piston is displaced by the introduced fluid. Should the flask continue to be filled until the piston abuts wall 51, and the pump continue to operate after the flask is completely full, the bypass at 44 will then open due to the increased pressure head to thereby recirculate the fluid back through the pump system, thus obviating damage to the system. Furthermore, should a valve downstream of the pump inadvertently be left closed, the bypass 44 will recirculate the pumped fluid.

The magnet 52, since it is slidably placed in a track, or the like, and located longitudinally along and adjacent to the flask 26, will tend to follow the piston since the wall of flask 26 is fabricated from non-magnetic material. The location of magnet 52 along the flask 26 indicates the position of piston 46, and accordingly indicates the amount of fluid that has entered the flask. The magnet may alternatively be placed in a channel or mounted upon a non-metallic rod.

After the sample has been obtained in the flask 26, the line valves 14 and 29, and safety valves 63, 63' are closed and the flask is disconnected at 27, 27' from pipe 10 and the pump 12, whereupon an empty flask may then be placed in service for the newly filled flask.

When the laboratory is ready to withdraw a portion of the fluid contained in the flask 26, a suitably excited coil may be placed peripherally about flask 26 and moved longitudinally up and down the flask, thereby carrying agitator 49 with it through magnetic attraction between the coil and agitator, thus mixing the sample contained in the flask.

When it is desired to return the flask 26 to service, valve 78 is opened and the excited coil (not shown) again placed about the flask and moved so as to place the piston 46 adjacent wall 50. The valve 78 is then closed and the flask is again ready to receive a sample.

In the embodiment illustrated by FIGURE 4, the flask 126 is preferably permanently installed adjacent a system to be sampled; as for example, a fluid carrying pipe line 10. Fluid conduit 25 operatively connects the system to a pump means 12 such as seen in FIGURE 1. After the sample flask 126 is filled with fluid from the conduit 10, the solenoid coil 128 may be suitably excited and moved longitudinally of the flask so as to move the perforated plate 149 between end walls 150 and 151 by the magnetic force exerted by solenoid coil 128 in order to blend the contents of the flask. Thereafter, valves 110, 263, and 264 are opened so as to fill laboratory sample flask 226 with a homogeneous fluid sample from chamber 148'. Transfer of liquid from chamber 148' into chamber 248 may be accomplished by using solenoid 128 to magnetically attract and move the barrier or piston 146 toward wall 150 thereby displacing the fluid from chamber 148' whereupon the fluid will flow through valve 110, quick disconnect 112, fluid conduit 114, T-connection at 261, quick disconnect 116, valve 263, and hence into chamber 248 thereby displacing piston 246 until it abuts wall 250. After filling sample flask 226, valves 264 and 263 are closed by using a suitable valve handle that mates with valve stem 265, 267 through apertures 266 and 268. Valve 110 is then closed, valve 178 opened and piston 146 returned to wall 150 through the means of the magnetic attraction of solenoid 128. Valve 178 is then closed and valves 163 and 163' opened whereupon the sample flask 126 begins to collect another fluid sample from fluid conduit 10 in accordance with the fluid flow from the double acting pump.

The action of the perforated plate 149 against the inside wall of the chamber 126 will remove or scrape any viscous material therefrom which will subsequently enter







into solution with the remaining fluid in the chamber 148' as the fluid is agitated by the mixer 149. The squeegee like action of the O-rings 147, 147' will remove any remaining fluid particles from the wall to accordingly present a clean chamber to the next incoming sample.

Where a predetermined quantity of fluid is desired to be transferred from flask 126 of FIGURE 4 into the laboratory flask 226, a graduated cylinder or burette 229 may be attached to quick disconnect 166 to enable a measured quantity of fluid to be displaced from chamber 248' by the equivalent quantity of sampled fluid entering chamber 248. Hence, the volume of fluid transferred to the burette is substantially equal to the volume of fluid transferred to laboratory flask 226.

Accordingly, while particular embodiments of this invention have been shown and described in detail herein, it will occur to those skilled in the art that various changes and modifications can be accomplished without departing either in spirit or scope from the invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A sampling device including a double acting pump and a flask, fluid conduits adapted to interconnect said pump and said flask to a fluid system to be sampled, said flask having opposed inlet and outlet ends connected by a flask wall, barrier means slidably located within and in sealing relationship with said flask wall and being movable from one to another said opposed ends, a check valve located in each said end having a spring biased ball check valve that normally permits flow in a single direction, means for selectively forcing said valve open to permit flow in an opposite direction to enable extraction of said sample, said fluid conduits including a branched inlet conduit for delivering fluid from the system to each action of said pump, a branched return outlet conduit for delivering fluid from said pump to said flask, and overload bypass means interconnecting the last said conduit with said inlet conduit.

2. The device of claim 1 wherein said flask is cylindrical, movable magnetic sensing means adjacent the outer container wall, said barrier means including a piston comprised of a magnet, said flask being fabricated from a non-magnetic material, whereby; said sensing means locates said piston to thereby gauge the amount of sample in said flask.

3. The device of claim 2 wherein said opposite end walls are connected together by a fluid carrying conduit having a valve therein, whereby; said piston is magnetically movable from one to an opposite said end wall in response to a magnetic force applied externally of said wall.

4. The device of claim 2 further including a magnetic perforated plate mounted for movement inside said wall and between said piston and said inlet end, whereby; said plate may be moved from said piston to said inlet wall in response to an external magnetic force to thereby agitate and mix the contents of said flask.

5. The device of claim 1 wherein said double acting pump includes a non-magnetic cylinder having opposite ends and an armature slidably located therein, solenoid coils located peripherally about said cylinder to impart translatory motion to said armature longitudinal of said cylinder upon energization of said coils, a pump head carried by each end of said cylinder and including an inlet check valve, an outlet check valve, a pumping cavity, and a piston sealingly and movably located in said cavity and operatively attached to said armature, said branched inlet conduit adapted to be connected at said inlet valve, said branched outlet conduit adapted to be connected at said outlet valves, whereby; alternate energization of said coils impart reciprocating motion to said pistons to move fluid from said system to said flask.

6. The apparatus of claim 5, and further including means forming an aperture through said armature, means



forming an adjustable rod mounted in each pump head and aligned with the first said aperture, each said adjustable rod extending into said armature aperture at an extreme end of travel of said armature to thereby provide a fluid cushioned stop.

7. The apparatus of claim 6 wherein one said adjustable rod has a reduced end portion so as to provide an adjustable orifice in conjunction with said armature aperture.

8. The invention of claim 1 wherein said check valve further includes a threaded base including a first passageway for housing said ball and spring, a body having a second passageway and received in said threaded base, a valve stem retainer received in said body and having means forming a centrally located aperture, a valve stem mounted for movement in and aligned with said first and second passageway and said aperture, fluid sealing means between said base, body, retainer, and stem, and a lateral passageway connecting said second passageway and forming an inlet means under normal operation as a check valve and forming an outlet means when said ball is upset by said stem.

9. A sampling system including fluid moving means connected to a fluid source to be sampled in a flask, fluid conduits adapted to connect said flask to said fluid moving means, said flask having opposed ends connected by a non-magnetic cylindrical wall, inlet means located in one said end and outlet means located in an opposed said end, magnetic piston means slidably located within and in sealing relationship with said cylindrical wall to form a first and second chamber, and means for moving said piston from one to the other said opposed ends to thereby enable said fluid moving means to fill said first chamber with fluid while displacing said piston from the inlet end to the outlet end; magnetic sensing means slidably located adjacent to and externally of said flask and movable in the same plane and direction as said piston for indicating the displacement of said piston from said inlet end, a perforated agitator slidably received in said first chamber whereby movement imparted to said agitator between the limits of said piston and said inlet wall will mix the fluid contents of said first chamber, and magnetic means for moving the agitator.

10. The device of claim 9 including a valve and a second flask;

means, including the last said valve, connecting said second flask to the first recited flask;

said second flask having end walls interconnected by a flask wall;

barrier means slidably located in sealing relationship with said second flask to thereby reciprocate between said end walls, whereby;

a laboratory sample may be transferred from said first flask into said second flask by moving the first said barrier means in a direction to provide flow through the last said valve and into said second flask.

11. A pump for use in sampling system comprising:

a non-magnetic housing having spaced detachable pump heads at each extremity; a pair of spaced solenoid coils peripherally wound about the outer periphery of said housing; an armature slidably received inside said housing and including two magnetic slugs spaced apart and integrally attached to a non-magnetic slug to thereby form a unitized armautre body; said armature having a length that is less than the length of the housing portion separating said pump heads from each other; one said magnetic slug being mis-aligned with one nearest adjacent said solenoid;

a pumping cavity centrally aligned with said pump head and said armature to form a cylinder that is adapted to receive a piston;

a piston slidably received in sealed relationship with said cylinder and adapted to reciprocate therein, means rigidly fastening said piston in each pump

head pumping cavity to the nearest adjacent said magnetic slug; inlet and outlet check valve means arranged in each said pump head and in fluid communication with said cavity to provide for one way flow through said pumping cavity at the free end of said piston;

a passageway longitudinally through said armature fluid connecting each extremity of said housing at said pump head; a rod adjustably mounted in each said pump head and aligned with said passageway, said rod having a diameter to permit close tolerance fit with said passageway; whereby: electrical energization of said solenoids causes longitudinal movement of said armature to thereby impart reciprocal motion to said piston and to thereby move a fluid through said pump heads, and; said rods cooperate with said passageway to form an adjustable fluid cushioned stop therewith.

12. A method of transferring a fluid from a pipeline or the like into a sample flask comprising:

(a) transferring a predetermined amount of fluid sample at a predetermined rate from said pipeline into a first flask;

(b) magnetically moving an agitator thus agitating the transferred sample to thereby provide a homogeneous fluid sample representative of the average fluid conditions of said flask;

(c) magnetically moving a piston to move a portion of the fluid from said first flask into a second flask to thereby provide a sample size suitable for laboratory determination;

(d) magnetically moving a second piston thus removing the contents of said second flask for laboratory analysis.



13. The method of sampling a fluid system, the steps comprising:

(a) transferring a predetermined amount of sample at a constant rate from said system to a first flask;

(b) agitating the accumulated sample in said flask to provide a homogeneous fluid sample representative of the average fluid contained in said system during step (a);

(c) withdrawing a portion of the fluid from the flask to provide a sample for laboratory analysis,

(d) providing said flask with an internal magnetically movable wall to thereby form a chamber having a variable volume equal to the volume of sample accumulated at a given time interval;

(e) transferring said withdrawn accumulated sample from said flask to a second flask;

(f) providing said second flask with a movable wall that maintains the volume of said second flask equal to the volume of the withdrawn fluid, whereby;

(g) said second flask may be used to obtain a sample from said first flask for laboratory determination.

14. The method of claim 13 and further including the steps of magnetically moving the movable wall of said first and second flask by an external magnetic field.


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# United States Patent [19]

**Miyamoto**

[11] **Patent Number: 4,488,477**

[45] **Date of Patent: Dec. 18, 1984**


[54] **RODLESS CYLINDER**


[75] Inventor: **Michikazu Miyamoto, Soka, Japan**

[73] Assignee: **Shoketsu Kinzoku Kogyo Kabushiki Kaisha, Tokyo, Japan**



[21] Appl. No.: **436,367**

[22] Filed: **Oct. 25, 1982**

[30] **Foreign Application Priority Data**

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[51] Int. Cl.³ ..... F01B 11/02

[52] U.S. Cl. ..... 92/85 R; 92/255; 91/DIG. 4; 60/545

[58] Field of Search ..... 91/1, DIG. 4; 92/51, 92/52, 5 R, 85 R, 255; 200/81.9 M, 82 E, 83 L; 60/545; 335/302, 306, 288



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*Assistant Examiner*—Scott L. Moritz

*Attorney, Agent, or Firm*—Oblon, Fisher, Spivak, McClelland & Maier


[57] **ABSTRACT**


A rodless cylinder having a piston and an operation member slidable along the outer circumferential surface of a cylinder tube, each mounted with permanent magnets, and adapted to move the operation member along the cylinder tube by utilizing the attraction force between these permanent magnets, in which a plurality of individual magnets disposed axially to the cylinder in each of driving and driven magnet rows are arranged such that identical poles of the individual magnets are in adjacent to each other, and both of the driving and driven magnet rows are arranged such that the different poles of the individual magnets in each of the magnet rows are opposed to each other can provide a greater attraction force between the magnet rows with no changes in the size of the magnet and thereby reduce the size of the entire apparatus.


**7 Claims, 4 Drawing Figures**

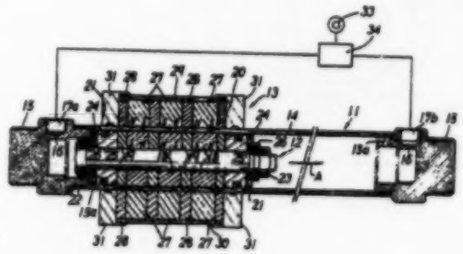


FIG. 1 PRIOR ART

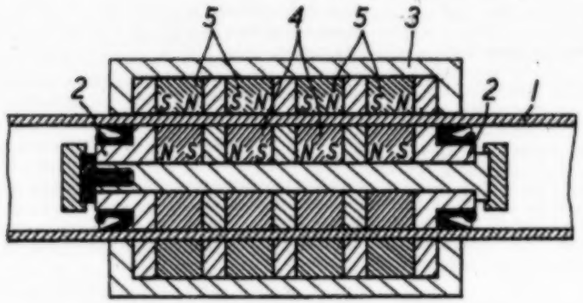



FIG. 4

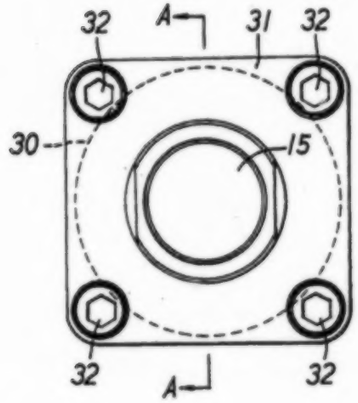







FIG. 2

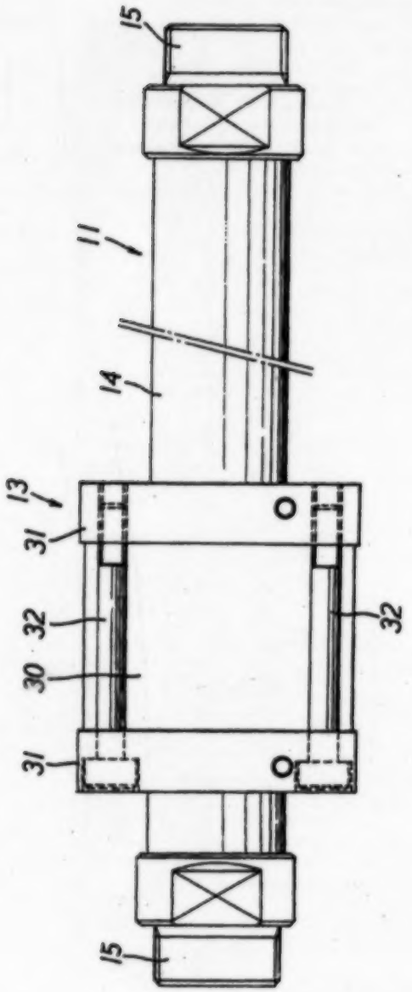
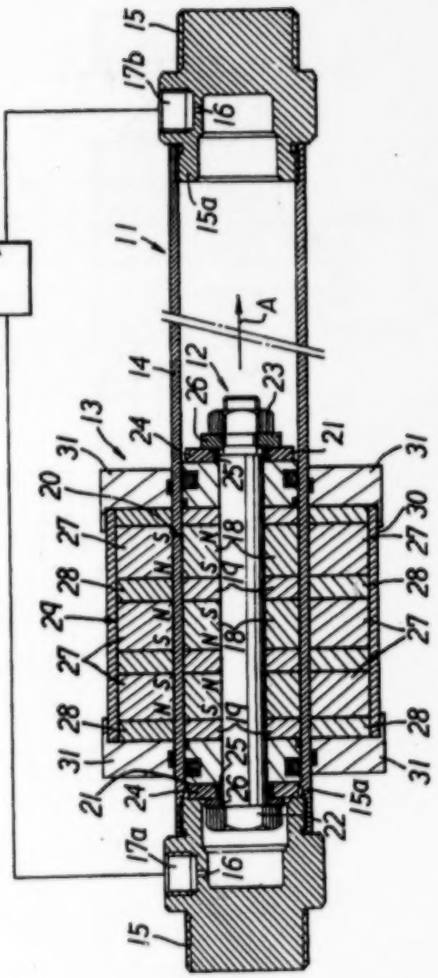


FIG. 3








# RODLESS CYLINDER

## BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention concerns a rodless cylinder.

(2) Description of the Prior Art

Cylinder apparatus in which a piston driven within a cylinder tube by the pressure of a fluid introduced therein have often been utilized generally. In the cylinder apparatus of this type, a rod mounted to the piston is extended from one end of a cylinder tube externally and a load is connected to the top end of the rod. However, in a state where the rod is projected to its extreme stroke end out of the cylinder tube, the entire length including the rod and the cylinder tube is approximately twice as long as the rod stroke. Thus, the cylinder apparatus of this type requires a relatively large installation space as compared with the stroke of the piston rod.

In view of the above, a so-called rodless cylinder has been developed as disclosed in Japanese Patent Publication No. 25034/1980 filed in Japan based on British Patent Application No. 4890/1971, in which a piston and an operation member slidion along the outer circumferential surface of a cylinder tube are mounted with permanent magnets respectively and the operation member is moved along the cylinder tube by utilizing the attraction force between the permanent magnets. FIG. 1 shows a schematic structure of the rodless cylinder, wherein a piston 2 disposed in a cylinder tube 1 and an operation member 3 fitted over the outer circumferential surface of the cylinder tube 1 are respectively mounted with magnet rows each consisting of a plurality of permanent magnets 4, 4, . . . and 5, 5, . . . arranged side by side and the different poles of the individual magnets in each of the magnet rows are opposed to each other respectively, so that the operation member is moved by the attraction force between the permanent magnets 4 and 5 following after the movement of the piston 2 driven by the pressure of a fluid. By the way, in the rodless cylinder as described above, the magnets 4 and 5 are arranged in the axial direction of the cylinder tube 1 with the different poles of the individual magnets in each of the magnet rows being adjacent to each other. Accordingly, it is necessary to increase the magnetic force, i.e., the size, or the number of the magnets constituting the magnet row in order to enhance the attraction of holding force between the magnet rows. This, however, increases the size and the cost of the entire apparatus, which is contrary to the essential purpose of the rodless cylinder of reducing the apparatus size.

## BRIEF SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide a rodless cylinder capable of obtaining a greater attraction force between a driving magnet row mounted to a piston and a driven magnet row disposed to the outer circumferential surface of a cylinder tube with no changes in the size and the number of the magnets by providing an adequate pole arrangement for the individual magnets in each of the driving and driven magnet rows.

Another object of this invention is to provide a rodless cylinder capable of obtaining a greater attraction force between the driving magnet row and the driven magnet row, which enables the use of small-sized magnets, thereby reducing the size and the cost of the apparatus.

A further object of this invention is to provide a rodless cylinder in which the driven magnet row can surely move following after the movement of the driving magnet row by a greater attraction force between the driving magnet row and the driven magnet row.

Other objects and aspects of this invention will become clearer by reading the following explanations for preferred embodiments of this invention in conjunction with the appended drawings.

The above objects can be attained by the rodless cylinder in accordance with this invention, in which a driving member driven within a cylinder in a axial direction by the pressure of a fluid is constituted by mounting a driving magnet row to a piston sliding in the cylinder and a driven member disposed to the outer circumference of the cylinder axially slidably is mounted with a driven magnet row, wherein a plurality of individual magnets disposed axially to the cylinder in each of the magnet rows are arranged such that the identical poles of the individual magnets are in adjacent to exch other, and each of the magnet rows are arranged such that the different poles of the individual magnets are opposed to each other.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view for a part of a conventional rodless cylinder,

FIG. 2 is a side view for a preferred embodiment according to this invention,

FIG. 3 is a cross sectional view taken along the line A—A in FIG. 4, and

FIG. 4 is an end view of the rodless cylinder shown in FIG. 2.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention is to be described specifically by way of its preferred embodiment referring to the drawings. In FIG. 2 through FIG. 4 are shown a cylinder 11, a pistonlike driving member 12 inserted fittedly to the inside of the cylinder 11 axially slidably and a driven member 13 which moves following after the movement of the driving member 12.

The cylinder 11 comprises a cylinder tube 14 made of non-magnetic material such as aluminum and head covers 15, 15 threadingly secured to the both ends thereof. Each head cover 15 is perforated with charge and discharge ports 17*a*, 17*b* for high pressure fluid in communication with the inside of the cylinder tube 14 by way of through holes 16.

The driving member 12 is adapted to reciprocate axially within the cylinder by the pressure of a high pressure fluid charged and discharged to and from the charge and discharge ports 17*a*, 17*b* in the head covers 15, 15. The driving member 12 comprises a driving magnet row 20 formed by alternately arranging a plurality of permanent magnets 18, 18, . . . and yokes 19, 19, . . . each with a central aperture, which are put between a pair of pistons 21, 21 and integrated, by being clamped with a bolt 22 inserted through the central apertures and a nut 23, together with dampers 24, 24 for abutting against stoppers 15*a* situated on the stroke ends within the cylinder, damper washers 25, 25 for restricting the compression of the dampers and flat washers 26, 26 abutting against the surface of the dampers for holding the same.

The driven member 13 in the form of a ring is inserted over the outer circumference of the cylinder tube 14 axially slidably and it comprises a driven magnet row 29 formed by alternately disposed a plurality of ring-like permanent magnets 27, 27, . . . and yokes 28, 28, . . . which are covered by a tube 30 at the outer circumference of the magnet row and fitted with a pair of fixing covers 31, 31 at the both ends of the tube 30 and integrated by being clamped with a bolts 32 inserted between the fixing covers 31, 31.

In each of the magnet rows 20 and 29, individual permanent magnets 18, 27 are arranged axially to the cylinder 11 such that the identical poles of the individual magnets are in adjacent to each other. The magnet rows 20 and 29 are arranged such that the different poles of the corresponding magnets 18 and 27 in each of the rows are opposed radially to each other by way of the cylinder tube 14.

Specifically, in the driving magnet row 20, a plurality of individual permanent magnets 18, 18 are arranged in the adverse direction alternately so that their identical poles S, S and N, N are adjacent to each other. In the driven magnet row 29, a plurality of individual magnets 27, 27, . . . corresponding in the number to that in the driving magnet row are arranged such that their identical poles S, S and N, N are adjacent to each other. Further, the driving magnet row 20 and the driven magnet row 29 are arranged such that the N poles of the individual magnets in the driving magnet row 20 are opposed to the S poles of the individual magnets in the driven magnet row 29 and S poles of the individual magnets in the driving magnet row 20 are opposed to the N poles of the individual magnets in the driven magnet row 29 respectively.

In the drawing, also shown are a pressurized fluid source 33, and a switching valve 34 that switchingly supplies a pressurized fluid from the pressurized fluid source 33 to either one of the charge and discharge ports 17*a*, 17*b* in the head cover 15 and discharges the pressurized fluid from the other of the charge and discharge ports to the outside.

In the rodless cylinder having a constitution as described above, when a high pressure fluid is supplied from the charge and discharge port 17*a* to the cylinder 11 at the switching position shown in FIG. 3, the driving member 12 moves in the direction of the arrow A while discharging the fluid on the opposite side in the inside of the cylinder 11 through the other charge and discharge port 17*b*, whereby the driven member 13 moves by the attraction force between both of the magnet rows 20 and 29 following after the movement of the driving member 12. Alternately, when a high pressure fluid is supplied to the charge and discharge port 17*b*, the driving member 12 and the driven member 13 can be driven in the opposite direction.

In the rodless cylinder of the illustrated embodiment, since the magnets 18, 27 in the magnet rows 20, 29 are arranged respectively so that the identical pole of the individual magnets are adjacent to each other in each of the rows, the attraction force between both of the magnet rows 20 and 29 can be made remarkably greater as compared with that of the embodiment shown in FIG. 1, wherein the different poles for the magnets 4, 4, . . . and 5, 5, . . . are adjacent to each other in the axial direction in each of the magnet rows at the inside and the outside of the cylinder 1.

Table I shows the results of the measurement for the difference in the attraction force between the magnet rows in each of three types of rodless cylinders having the same basic structure, with respect to the case where the magnets are arranged according to this invention and in the case where the magnets are arranged in the conventional manner as shown in FIG. 1. As apparent from the Table I, the magnet arrangement according to this invention can increase the attraction force between the magnet rows approximately five times as large as that of the embodiment shown in FIG. 1.

TABLE I

| | Arrangement (in this invention) | Arrangement (in the prior embodiment) |
|---|---|---|
| Cylinder I | 13.6 (kgf) | 2.35 (kgf) |
| Cylinder II | 13.4 | 2.33 |
| Cylinder III | 13.0 | 2.25 |

As stated above, the attraction force between the magnet rows can be increased significantly by the rodless cylinder according to this invention, in a simple structure wherein a plurality of individual magnets are arranged appropriately, in each of the driving magnet row mounted to the piston disposed to the inside of the cylinder and the driven magnet row disposed to the outside of the cylinder.

What is claimed is:

1. A rodless cylinder, in which a driving member driven within a cylinder in the axial direction by the pressure of a fluid is constituted by mounting a driving magnet row to a piston sliding in said cylinder and a driven member disposed to the outer circumference of said cylinder axially slidably is mounted with a driven magnet row, wherein a plurality of individual magnets disposed axially to the cylinder in each of said magnet rows are arranged such that the identical poles of said individual magnets are adjacent to each other, and each of said magnet rows are arranged such that the different poles of said individual magnets are opposed to each other.

2. The rodless cylinder as defined in claim 1, wherein said driving magnet row is formed by alternately arranging a plurality of driving magnets and yokes having central apertures perforated therein respectively and said driven magnet row is formed by alternately arranging a plurality of ring-like driven magnets and yokes.

3. The rodless cylinder as defined in claim 1, wherein said driving magnet row comprises a plurality of permanent magnets which are arranged so that the individual magnets are disposed with their identical poles, that is, S, S and N, N being adjacent to each other respectively, and said driven magnet row also comprises a plurality of permanent magnets corresponding in number to that of said driving magnet row which are arranged so that the individual magnets are disposed with their identical poles, that is, S, S and N, N being in adjacent to each other respectively, and in which said driving magnet row and the driven magnet row are arranged such that the N poles of the individual magnets in one of the magnet rows correspond to the S poles of the individual magnets in the other of the magnet rows respectively while the S poles in the individual magnets in one of the magnet rows correspond to the N poles of the individual magnets in the other of the magnet rows respectively.

4. The rodless cylinder as defined in claim 1, wherein said driving magnet row is put between a pair of pistons and they are integrated together with dampers abutting against stoppers situated at the stroke ends in the cylinder by being clamped with a bolt inserted through central apertures in said individual magnets.

5. The rodless cylinder as defined in claim 1, wherein the driven magnet row is covered at the outer periphery thereof with a tube the axial length of which corresponds to the axial length of said driven magnet row, wherein said driven magnet row is fitted with a pair of cup-shaped fixing covers on both ends of said tube, each end of said driven magnet row and said tube being received in one of said cup-shaped covers, and wherein said driven magnet row, said tube, and said cup-shaped fixing covers are integrated by being clamped with a plurality of bolts inserted between said fixing covers.

6. The rodless cylinder as defined in claim 4, wherein said cylinder is fitted with a head cover at either end thereof, said head covers contain inwardly directed axial recesses which receive the ends of said bolt at the stroke ends, and said stoppers project axially inwardly from said head covers radially outwardly of said axial recesses.

7. A rodless cylinder having a cylinder, a driving member which is assembled with a piston and a driving magnet row slidably disposed in said cylinder and movable therein by a pressurized fluid along the axial direction of said cylinder, and a driven member which has a driven magnet row surrounding the outer periphery of said cylinder, each of said driving and driven magnet rows comprising a plurality of individual permanent magnets juxtaposed along the cylinder axis, characterized in that axially adjacent pairs of permanent magnets in each row are arranged to face identical poles in the axially adjacent magnets, thereby turning lines of magnetic force substantially perpendicularly to the cylinder axis, while radially opposed pairs of magnets are arranged to face different poles, thereby preventing independent movements of said rows, whereby said driven member stably follows the movement of said driving member.

* * * * *

# REEXAMINATION CERTIFICATE (1428th)


**United States Patent** [19] [11] **B1 4,488,477**

**Miyamoto** [45] Certificate Issued **Mar. 12, 1991**


[54] **RODLESS CYLINDER**


[75] Inventor: **Michikazu Miyamoto, Soka, Japan**

[73] Assignee: **Shoketsu Kinzoku Kogyo Kabushiki Kaisha, Japan**



**Reexamination Request:**
No. 90/001,910, Dec. 18, 1989

**Reexamination Certificate for:**

| | |
|---|---|
| Patent No.: | 4,488,477 |
| Issued: | Dec. 18, 1984 |
| Appl. No.: | 436,367 |
| Filed: | Oct. 25, 1982 |

[30] **Foreign Application Priority Data**

Nov. 19, 1981 [JP] Japan ..... 56-172476

[51] Int. Cl.³ ..... F01B 11/02

[52] U.S. Cl. ..... 92/85 R; 92/255; 91/DIG. 4; 60/545

[58] Field of Search ..... 91/1, DIG. 4; 92/51, 92/52, 5 R, 85 R, 255; 200/81.9 M, 82 E, 83 L; 60/545; 335/302, 306, 288; 417/418



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*Primary Examiner*—Edward Look


[57] **ABSTRACT**


A rodless cylinder having a piston and an operation member slidable along the outer circumferential surface of a cylinder tube, each mounted with permanent magnets, and adapted to move the operation member along the cylinder tube by utilizing the attraction force between these permanent magnets, in which a plurality of individual magnets disposed axially to the cylinder in each of driving and driven magnet rows are arranged such that identical poles of the individual magnets are in adjacent to each other, and both of the driving and driven magnet rows are arranged such that the different poles of the individual magnets in each of the magnet rows are opposed to each other can provide a greater attraction force between the magnet rows with no changes in the size of the magnet and thereby reduce the size of the entire apparatus.


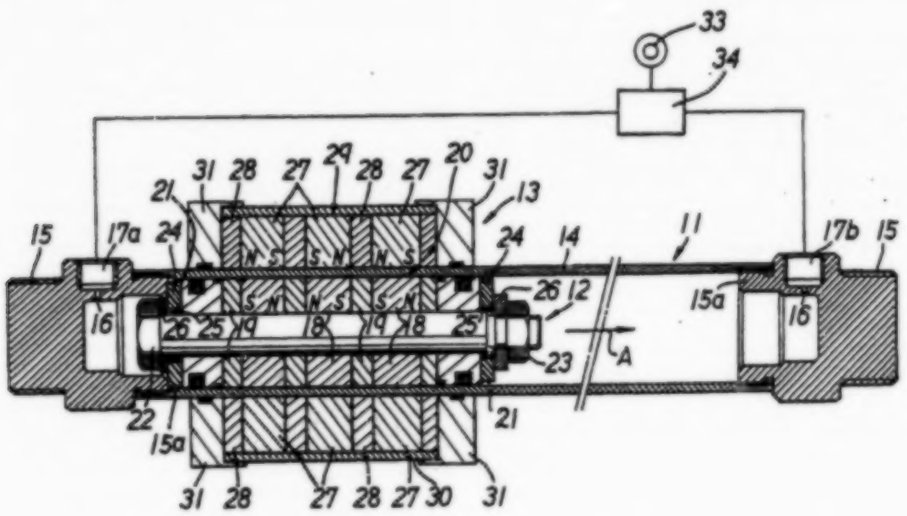






FIG. 1 *PRIOR ART*

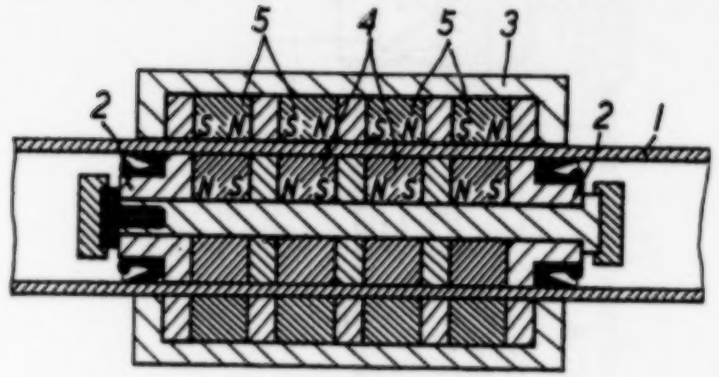


FIG. 4

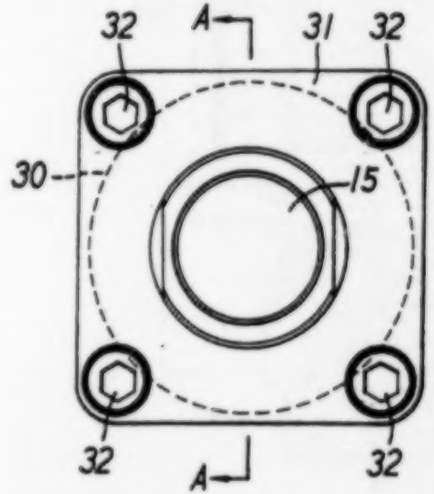

FIG. 2

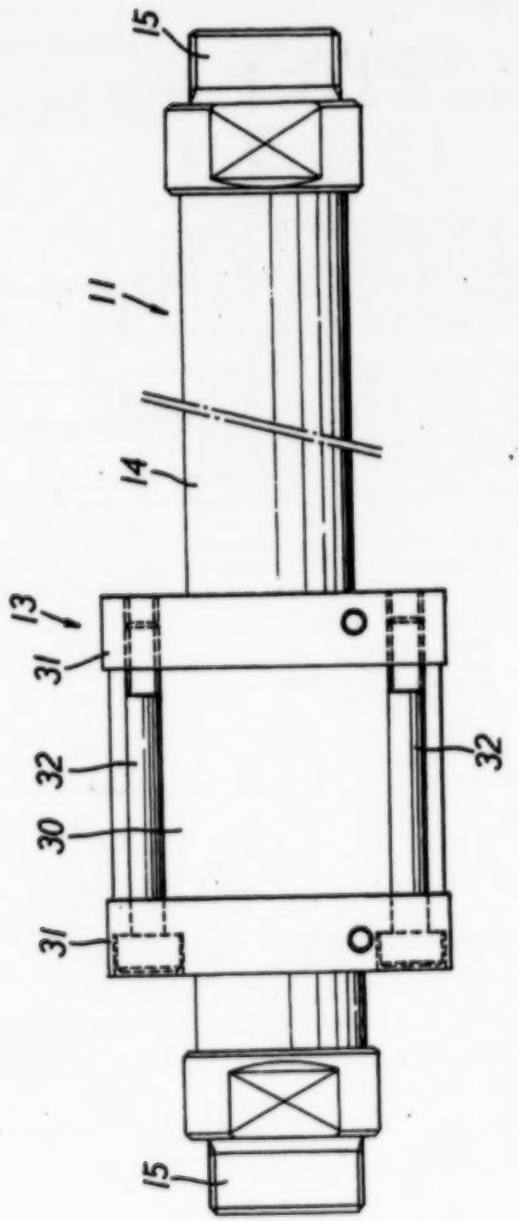
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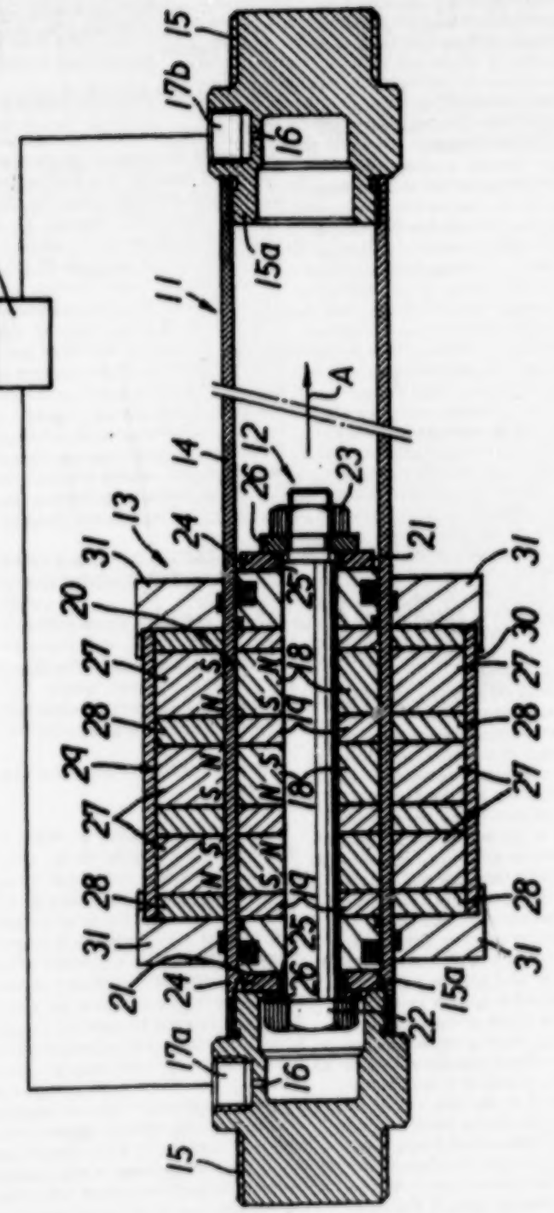
FIG. 3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# REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

**Matter enclosed in heavy brackets [ ] appeared in the patent, but has been deleted and is no longer a part of the patent; matter printed in italics indicates additions made to the patent.**

ONLY THOSE PARAGRAPHS OF THE SPECIFICATION AFFECTED BY AMENDMENT ARE PRINTED HEREIN.

Amend the paragraph beginning at line 12 of column 2:

The above objects can be attained by the rodless cylinder in accordance with this invention, in which a driving member driven within a cylinder in a axial direction by the pressure of a fluid is constituted by mounting a driving magnet row to a piston sliding in the cylinder and a driven member disposed to the outer circumference of the cylinder axially slidably is mounted with a driven magnet row, wherein a plurality of individual magnets disposed axially to the cylinder in each of the magnet rows are arranged such that the identical poles of the individual magnets are in adjacent to each other, and each of the magnet rows are arranged such that the different poles of the individual magnets are opposed to each other. *The driving magnet row is put between a pair pistons and integrated together. Dampers abut against stoppers situated at the stroke ends in the cylinder by being clamped with a bolt inserted through central apertures in the individual magnets. The cylinder is fitted with a head cover at either end thereof. The head covers contain inwardly directed axial recesses which receive the ends of the bolt at the stroke ends. The stoppers project axially inwardly from the head covers at locations radially outwardly of the axial recesses.*

*According to another feature of the invention, the rodless cylinder comprises an elongated cylinder formed of a non-magnetic material, head covers releasably connected to two axial ends of said cylinder, each of said head covers comprising an inwardly directed axial recess, an annular stopper projecting axially inwardly from said head cover at a position radially outward of said axial recess, and a port for supplying a pressurized fluid to the cylinder via the axial recess. A driving member fitted in the cylinder and movable in the cylinder in the axial direction thereof includes an alternating plurality of permanent magnets and yokes, the permanent magnets of the driving member being arranged such that identical poles of adjacent magnets face one another, a threaded rod passing through central apertures of the permanent magnets and yokes of the driving member, a pair of pistons secured to opposite ends of the plurality of magnets and yokes of the driving member by the threaded rod, and a pair of flat ring shaped dampers fitted to the driving member adjacent opposite axial ends thereof, the dampers extending axially to a position such that each of the dampers abuts a respective one of the stoppers when an axial end of the driving member enters the axial recess at an end of a stroke of the driving member, so that an area of contact between the dampers and stoppers is radially outside of the cylinder and is movable along the cylinder in the axial direction thereof. The driven member includes an alternating plurality of permanent magnets and yokes in radial alignment with the permanent magnets and yokes of the driving member, the magnets of the driven member being arranged such that identical poles of adjacent magnets face one another and such that radially aligned pairs of magnets of the driving and driven members have opposite poles in opposed alignment with each other, as well as a tube covering the outer circumference of the magnets and yokes of the driving member, and means for axially clamping the magnets and yokes of the driven member.*



Amend the paragraph beginning at line 53 of column 2.

The driving member 12 is adapted to reciprocate axially within the cylinder by the pressure of a high pressure fluid charged and discharged to and from the charge and discharge ports 17a, 17b in the head covers 15, 15. The driving member 12 comprises a driving magnet row 20 formed by alternately arranging a plurality of permanent magnets 18, 18, . . . and yokes 19, 19, . . . each with a central aperture, which are put between a pair of pistons 21, 21 and integrated, by being clamped with a bolt 22 (*i.e., a type of threaded rod*) inserted through the central apertures and a nut 23, together with dampers 24, 24 for abutting against stoppers 15a situated on the stroke ends within the cylinder *when the end of the driving member 12 enters an axial recess in the head cover 15 at the end of a stroke*, damper washers 25, 25 for restricting the compression of the dampers and flat *ring shaped* washers 26, 26 abutting against the surface of the dampers for holding the same. *The stoppers 15a are located radially outside of the axial recesses.*

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

Claims 4, 6 and 7 are cancelled.

Claim 1 is determined to be patentable as amended.

Claims 2, 3 and 5, dependent on an amended claim, are determined to be patentable.

New claims 8 and 9 are added and determined to be patentable.

1. A rodless cylinder, in which a driving member driven within a cylinder in the axial direction by the pressure of a fluid is constituted by mounting a driving magnet row to a piston sliding in said cylinder and a driven member disposed to the outer circumference of said cylinder axially slidably is mounted with a driven magnet row, wherein a plurality of individual magnets disposed axially to the cylinder in each of said magnet rows are arranged such that the identical poles of said individual magnets are adjacent to each other, and each of said magnet rows are arranged such that the different poles of said individual magnets are opposed to each other [.], *wherein said driving magnet row is put between a pair of pistons and they are integrated together with dampers abutting against stoppers situated at the stroke ends in the cylinder by being clamped with a bolt inserted through central apertures in said individual magnets, and wherein said cylinder is fitted with a head cover at either end thereof, said head covers contain inwardly directed axial recesses which receive the ends of said bolt at the stroke ends, and said stoppers project axially inwardly from said head covers radially outwardly of said axial recesses.*

*8. A rodless cylinder, comprising:*

*an elongated cylinder formed of a non-magnetic material;*

*head covers releasably connected to two axial ends of said cylinder, each of said head covers comprising an inwardly directed axial recess, an annular stopper projecting axially inwardly from said head cover at a position radially outward of said axial recess, and a port for supplying a pressurized fluid to said cylinder via said axial recess;*

*a driving member fitted in said cylinder and movable in said cylinder in the axial direction thereof, said driving member comprising:*

*(a) an alternating plurality of annular permanent magnets and yokes, said permanent magnets of said driving member being arranged such that identical poles of adjacent magnets face one another,*

*(b) a threaded rod passing through central apertures of said permanent magnets and yokes of said driving member,*

*(c) a pair of pistons secured to opposite ends of said plurality of magnets and yokes of said driving member by said threaded rod, and*

*(d) a pair of flat ring shaped dampers fitted to said driving member adjacent opposite axial ends thereof, said dampers extending axially to a position such that each of said dampers abuts a respective one of said stoppers when an axial end of said driving member enters said axial recess at an end of a stroke of said driving member, whereby an area of contact between said dampers and said stoppers is radially outside of said threaded rod; and*

*a driven member fitted to the outside of said cylinder and movable along said cylinder in the axial direction thereof, said driven member comprising:*

*(e) an alternating plurality of annular permanent magnets and yokes in radial alignment with said permanent magnets and yokes of said driving member, said magnets of said driven member being arranged such that identical poles of adjacent magnets face one another and such that radially aligned pairs of magnets of said driving and driven members have opposite poles in opposed alignment with each other,*

*(f) a tube covering the outer circumference of said magnets and yokes of said driven member, and*

*(g) means for axially clamping said magnets and yokes of said driven member.*

*9. A rodless cylinder having a driving member, including a plurality of driving magnets, reciprocable within said cylinder in response to the fluid pressure therein, and a driven member, including a plurality of driven magnets, mounted externally of said cylinder for reciprocable movement in response to the movement of said driving member, wherein the driving magnets are disposed within, and extend side-by-side lengthwise of, said cylinder and are arranged so that the adjacent poles of adjacent driving magnets are identical; wherein the driven magnets are disposed externally of said cylinder and extend side-by-side lengthwise thereof, and are arranged so that the adjacent poles of adjacent driven magnets are identical but are of opposite polarity to the corresponding poles of the driving magnets adjacent thereto within the cylinder; wherein adjacent driving magnets and adjacent driven magnets are both separated, respectively, by yokes; wherein said cylinder is closed at each end by head covers each of which is provided with charge and discharge ports for high pressure fluid; wherein said driven member comprises a tube spaced from and mounted freely around the outer circumference of the cylinder so as to be axially slidable relative thereto; wherein said driving member also comprises a pair of pistons between which said driving magnets and separating yokes are clamped by bolt means; wherein a disk-shaped damper is clamped by said bolt means against the outer end of each piston for abutting against annular stoppers situated at the stroke ends of the driving members in said cylinder, said stoppers being provided on the inner ends of said head covers and forming substantially planar abutment surfaces for abutment by the peripheral portions of the outer faces of said dampers; and wherein said head covers are recessed to receive the lengths of said bolt means which project outwardly of said outer faces of said dampers when said driving member is at said stroke ends.*

* * * * *